Phase II Appendices

Upper Columbia Basin Network (UCBN)
June 1, 2005

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Upper Columbia Basin Network Parks

Big Hole National Battlefield (BIHO)
City of Rocks National Reserve (CIRO)
Craters of the Moon National Monument & Preserve (CRMO)
Hagerman Fossil Beds National Monument (HAFO)
John Day Fossil Beds National Monument (JODA)
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Appendix A. Legislation and Policy

Appendix A-1. Summary of federal legislation and policy related to inventory and monitoring.

PUBLIC LAWS	SIGNIFICANCE TO INVENTORY AND MONITORING
National Park Service Organic Act (16 USC 1 et seq. [1988], Aug. 25, 1916).	The 1916 National Park Service Organic Act is the core of park service authority and the definitive statement of the purposes of the parks and of the National Park Service mission. The act establishes the purpose of national parks: "…. To conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."
General Authorities Act of 1970 (16 USC 1a-1-1a-8 (1988), 84 Stat. 825, Pub. L. 91-383)	The General Authorities Act amends the Organic Act to unite individual parks into the 'National Park System'. The act states that areas of the National Park System, "though distinct in character, are united through their inter-related purposes and resources into one national park system as cumulative expressions of a single national heritage; that individually and collectively, these areas derive increased national dignity and recognition of their superb environmental quality through their inclusion jointly with each other in one national park system preserved and managed for the benefit and inspiration of all the people of the United States…"
National Parks Omnibus Management Act, 1998 (P.L. 105-391)	Requires Secretary of Interior to continually improve NPS' ability to provide state of-the-art management, protection, and research on NPS resources. Section 5939 states that the purpose of legislation is to: (1) Enhance management and protection of national park resources by providing clear authority and direction for the conduct of scientific study in the National Park System and to use the information gathered for management purposes; (2) Ensure appropriate documentation of resource conditions in the National Park System; (3) Encourage others to use the National Park System for study to the benefit of park management as well as broader scientific value; and (4) Encourage the publication and dissemination of information derived from studies in the NPS.
National Historic Preservation Act of 1966, as amended (16 USC 470 et seq.)	Congress set forth in NHPA includes preserving 'the historical and cultural foundations of the Nation' and preserving irreplaceable examples important to our national heritage to maintain 'cultural, educational, aesthetic, inspirational, economic, and energy benefits.' NHPA established the National Register of Historic Places composed of places and objects 'significant in American history, architecture, archeology, engineering, and culture.' NHPA requires federal agencies to account for effects of actions on historic (state and federal) properties.
National Environmental Policy Act of 1969	The purposes of NEPA include encouraging 'harmony between [humans] and their environment and promote efforts which will prevent or eliminate damage to the environment… and stimulate the health and

(42 USC 4321-4370)	welfare of [humanity].' NEPA requires a systematic analysis of major federal actions that includes a consideration of all reasonable alternatives as well as an analysis of short-term and long-term, irretrievable, irreversible, and unavoidable impacts. Within NEPA the environment includes natural, historical, cultural, and human dimensions. Within the NPS emphasis is on minimizing negative impacts and preventing "impairment" of park resources as described and interpreted in the NPS Organic Act. The results of evaluations conducted under NEPA are presented to the public, federal agencies, and public officials in document format (e.g. EAs and EISs) for consideration prior to taking official action or making official decisions.
Clean Water Act (33 USC 1251-1376)	The Clean Water Act, passed in 1972 as amendments to the Federal Water Pollution Control Act, and significantly amended in 1977 and 1987, was designed to restore and maintain the integrity of the nation's water. It furthers the objectives of restoring and maintaining the chemical, physical and biological integrity of the nation's waters and of eliminating the discharge of pollutants into navigable waters by 1985. Establishes effluent limitation for new and existing industrial discharge into U.S. waters. Provides an enforcement procedure for water pollution abatement. Requires conformance to permit required under S404 for actions that may result in discharge of dredged or fill material into a tributary to, wetland, or associated water source for a navigable river.
Clean Air Act (42 USC 7401-7671q, as amended in 1990)	Establishes a nationwide program for the prevention and control of air pollution and establishes National Ambient Air Quality Standards. Under the Prevention of Significant Deterioration provisions, the act requires federal officials responsible for the management of Class I Areas (some national parks and wilderness areas) to protect the air quality related values of each area and to consult with permitting authorities regarding possible adverse impacts from new or modified emitting facilities. Establishes specific programs that provide special protection for air resources and air quality related values associated with NPS units. The EPA has been charged with implementing this act.
Endangered Species Act of 1973, as amended (ESA) (16 USC 1531-1544)	The purposes of the ESA include providing "a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved. According to the ESA 'all federal departments and agencies shall seek to conserve endangered species and threatened species ' and '[e]ach federal agency shall…insure that any action authorized, funded, or carried out by such agency…is not likely to jeopardize the continued existence of any endangered species or threatened species.' The effects of any agency action that may affect endangered, threatened, or proposed species must be evaluated in consultation with either the USFWS (non-marine species) or the National Marine Fisheries Service (all marine species) as appropriate.
Wilderness Act of 1964 (16 USC 1131 et	Establishes the National Wilderness Preservation System. Wilderness Areas designated by Congress are made of existing federal lands that have retained a wilderness character and meet the criteria found in the

seq.)	act. Federal officials are required to manage Wilderness Areas in a manner conducive to retention of their wilderness character and must consider the effect upon wilderness attributes from management activities on adjacent lands.
Federal Advisory Committee Act	Creates a formal process for federal agencies to seek advice and assistance from citizens. Any council, panel, conference, task force or similar group used by federal officials to obtain consensus advice or recommendations on issues or policies fall under the purview of FACA.
Government Performance and Results Act (GPRA)	Requires the NPS to set goals (strategic and annual performance plans) and report results (annual performance reports). The NPS Strategic Plan contains four GPRA goal categories: park resources, park visitors, external partnership programs, and organizational effectiveness all focused on measurable outcomes.
Other Related Public Laws and Executive Orders	Redwood National Park Act (16 USC 79a-79q (1988), 82 Stat. 931, Pub. L. 90-545; Environmental Quality Improvement Act of 1970 (42 U.S.C. 56 § 4371); Off-Road Vehicle Use (Executive Orders 11644 and 11989); Floodplain Management (Executive Order 11988); Protection of Wetlands (Executive Order 11990); and Executive Order 13112 on Invasive Species
NPS Management Policies – 2001 (NPS Directives System)	This is the basic NPS service wide policy document. The Directives System is designed to provide NPS management and staffs with clear and continuously updated information on NPS policy and required and/or recommended actions, as well as any other information that will help them manage parks and programs effectively.
NPS Directors Orders	Directors Orders serve a vehicle to clarify or supplement *Management Policies* to meet the needs of NPS managers. Relevant Directors Orders: DO-2.1 Resource Management Planning DO-12 Environmental Impact Assessment DO-14 Resource Damage Assessment & Restoration DO-24 Museum Collections Management DO-41 Wilderness Preservation & Management DO-47 Sound Preservation & Noise Management DO-77 Natural Resource Protection
NPS Handbooks and Reference Manuals	These documents are issued by Associate Directors and provide NPS field employees with a compilation of legal references, operating policies, standards, procedures, general information, recommendations and examples to assist them in carrying out *Management Policies* and Director's Orders. Level 3 documents may not impose any new service-wide requirements, unless the Director has specifically authorized them to do so. Relevant Handbooks and Reference Manuals: NPS-75 Natural Resources Inventory & Monitoring NPS-77 Natural Resources Management Guidelines NPS Guide to Fed. Advisory Committee Act Website: Monitoring Natural Resources in our National Parks, http://www.nature.nps.gov/im/monitor

Appendix A-2. Designation of National Park System Units

The numerous designations within the National Park System sometime confuse visitors. The names are created in the Congressional legislation authorizing the sites or by the president, who proclaims *"national monuments"* under the Antiquities Act of 1906. Many names are descriptive -- lakeshores, seashores, battlefields --but others cannot be neatly categorized because of the diversity of resources within them. In 1970, Congress elaborated on the 1916 National Park Service Organic Act, saying all units of the system have equal legal standing in a national system.

National Monument: The Antiquities Act of 1906 authorized the President to declare by public proclamation landmarks, structures, and other objects of historic or scientific interest situated on lands owned or controlled by the government to be national monuments (Craters of the Moon NM and Preserve, Hagerman Fossil Beds NM, John Day Fossil Beds, Minidoka Internment NM).

National Preserve: National preserves are areas having characteristics associated with national parks, but in which Congress has permitted continued public hunting, trapping, oil/gas exploration and extraction. Many existing national preserves, without sport hunting, would qualify for national park designation (Craters of the Moon NM and Preserve).

National Historic Site: Usually, a national historic site contains a single historical feature that was directly associated with its subject. Derived from the Historic Sites Act of 1935, a number of historic sites were established by secretaries of the Interior, but most have been authorized by acts of Congress (Whitman Mission NHS).

National Historical Park: This designation generally applies to historic parks that extend beyond single properties or buildings (Nez Perce NHP).

National Battlefield: This general title includes national battlefield, national battlefield park, national battlefield site, and national military park. In 1958, an NPS committee recommended national battlefield as the single title for all such park lands (Big Hole NB).

National Recreation Area: Twelve NRAs in the system are centered on large reservoirs and emphasize water-based recreation. Five other NRAs are located near major population centers. Such urban parks combine scarce open spaces with the preservation of significant historic resources and important natural areas in location that can provide outdoor recreation for large numbers of people (Lake Roosevelt NRA).

National Reserve: This unit of the National Park System is managed cooperatively by the National Park Service and the Idaho Department of Parks and Recreation (City of Rocks NR).

Appendix A-3. UCBN Resource Management and General Management Plan Summaries

Note: This information was assembled from various park documents, including general management plans, resource management plans, and strategic plans. This does not represent the comprehensive goals and objectives for each park but represents subsets that are most relevant to natural resource monitoring.

Big Hole National Battlefield
Source: NEPE/BIHO General Management Plan 1997

Big Hole National Battlefield	• Facilitate protection and offer interpretation of Nez Perce sites in Idaho, Oregon, Washington, Montana, and Wyoming that have exceptional value in commemorating the history of the United States. • Preserve and protect tangible resources that document the history of the Nez Perce peoples and the significant role of the Nez Perce in North American history. • Interpret the culture and history of the Nez Perce peoples and promote documentation to enhance that interpretation.	Purpose

City of Rocks National Reserve
Source: CIRO Resource Management Plan 1994

City of Rocks National Reserve	• To preserve, protect, and interpret the resources and significant values that contribute to City of Rocks' uniqueness and attractiveness. • To manage recreation to ensure preservation and protection of these resource values.	Purpose
	• Identify, inventory, evaluate, protect, and preserve the resources related to the California Trail. • Strive to preserve and restore natural resources. • Balance ecological relationships and processes with uses in the reserve. • Maintain natural conditions as much as possible. • Determine the location of and protect the important habitat used by rare species and species sensitive to human uses. • Protect air quality at the highest level possible under the Clean Air Act by working cooperatively with the state of Idaho to redesignate the area from Class II to Class I. • Conserve natural hydrological processes, including subsurface hydrology and control the acceleration of erosion due to human activities to preserve natural, cultural, and scenic resources. • Protect or restore wetlands and riparian areas by managing their use wherever possible. • Complete a comprehensive inventory of natural resources in the reserve.	Management Objectives

Craters of the Moon National Monument and Preserve

Source: CRMO Strategic Plan 2000-2005 and 1988 Statement for Management

Craters of the Moon National Monument and Preserve	• The purpose of Craters of the Moon National Monument is to preserve and protect the remarkable geological features, wilderness solitude, and natural systems that have shaped, and continue to shape the landscape of the Great Rift region of the Snake River plain.	Purpose
	• To preserve to the greatest extent possible the basaltic volcanism features of the monument through effective interpretation and protection programs. • To perpetuate the natural ecosystems of the monument through active and effective resource management programs. • To preserve visibility and associated vistas and to prevent deterioration of the airshed and all air quality related values. • To promote a continuing program of scientific research and study to gather information that will allow for long-term wildlife management programs. • To work on a cooperative basis with other government agencies, primarily the Bureau of Land Management, in matters of mutual concern such as the effect of stock grazing in the vicinity of the monument. • To establish objective policy and guidelines (backcountry management plan) that will ensure a strong and definite commitment by park management to the preservation of the monument's wilderness.	Management Objectives

Hagerman Fossil Beds National Monument

Source: HAFO General Management Plan 1996

Hagerman Fossil Beds National Monument	• To preserve for the benefit and enjoyment of present and future generations the outstanding paleontological sites known as the Hagerman Valley fossil sites.	Purpose
	• Preserve and protect the paleontological resources of the Hagerman Valley fossil sites, including both specimens and their context. • Encourage and support scientific research and related activities associated with monument resources and the science of paleontology. • Preserve, protect, and interpret the natural and cultural resources associated with the monument. • Cooperatively manage hunting and fishing in the monument to ensure the continuance of this historic use as legislatively required, while protecting monument resources, values, public safety, research, and other authorized activities. • Cooperate with the operation, maintenance, repair, upgrade, and modification of existing electrical and irrigation facilities within the boundaries of the monument as legislatively required while minimizing any adverse impacts of these activities on monument resources, values, research, or visitors.	Management Goals

John Day Fossil Beds National Monument

Source: JODA Resource Management Plan 1999

John Day Fossil Beds National Monument	• Establishment of the monument is intended to preserve, protect, and interpret the extensive tertiary fossils found in the geologic formations of these areas.	Purpose
	• Encourage resource-compatible activities or scientific investigations of the monument, which results in obtaining and sharing knowledge of the paleontological, geological, and ecological scientific study of the region. • In areas designated as "natural zones", maintain or restore indigenous flora, fauna, and natural communities to achieve species diversity and community structure equivalent to pre-European settlement conditions. • Identify, determine the significance of, and protect the monument's natural and cultural resources.	Management Goals

Lake Roosevelt National Recreation Area
Source: LARO Fire Management Plan 2000

Lake Roosevelt National Recreation Area	• Provide opportunities for diverse, safe, quality, outdoor recreation experiences for the public. • Preserve, conserve, and protect the integrity of natural, cultural, and scenic resources. • Provide opportunities to enhance public appreciation and understanding about the area's significant resources.	Purpose

Minidoka Internment National Monument
Source: MIIN Draft Management Plan 2004

Minidoka Internment National Monument	• The purpose of the Minidoka Internment National Monument is to provide opportunities for public education and interpretation of the incarceration and internment of Japanese Americans during WWII. The monument protects and manages resources related to the Minidoka Relocation Center.	Purpose
	• Protection and management of natural resources and the site. • Control of exotic plant species. • Fire management. • Hunting and the protection of sage grouse habitat.	Identified Management Issues

Nez Perce National Historic Park

Source: NEPE/BIHO General Management Plan 1997

Nez Perce National Historic Park	• Facilitate protection and offer interpretation of Nez Perce sites in Idaho, Oregon, Washington, Montana, and Wyoming that have exceptional value in commemorating the history of the United States. • Preserve and protect tangible resources that document the history of the Nez Perce peoples and the significant role of the Nez Perce in North American history. • Interpret the culture and history of the Nez Perce peoples and promote documentation to enhance that interpretation.	Purpose

Whitman Mission National Historic Site

Source: WHMI General Management Plan 2000

Whitman Mission National Historic Site	• To preserve and maintain the site of the Mission and school for Indians established by Marcus and Narcissa Whitman between 1836-1847 along the Walla Walla River at Waiilatpu, and to preserve and maintain the memorials to their lives.	Purpose
	• To preserve and protect the historic, cultural, and natural resources of Whitman Mission National Historic Site for present and future generations. • To preserve and enhance the natural resources of the NHS, including riparian and wetland areas, in accord with all applicable laws, NPS policies, and executive orders.	Mission Goals

Appendix B. Ecological Context

Appendix B-1. Individual park descriptions

BIG HOLE NATIONAL BATTLEFIELD (BIHO)

Size: 265 hectares (655 acres)

Designation Date: 1910

Park History and Purpose: Big Hole National Battlefield is a memorial to the people who fought and died there on August 9 and 10, 1877. They were combatants in a five month conflict that came to be called the Nez Perce War of 1877. Like other Indian Wars in the late 1800's, the Nez Perce War involved two very different groups with very different outlooks on land rights, civilian authority, government powers, social organization, and the responsibilities of the individuals to society. In 1992, legislation incorporated Big Hole National Battlefield with Nez Perce National Historical Park, making it part of a unique park consisting of 38 different sites located in five states; Oregon, Washington, Idaho, Montana, and Wyoming.

Location: Big Hole National Battlefield is approximately 75 miles southwest of Butte, Montana and about 110 miles southeast of Missoula, Montana in southwestern Montana. The park is located in the western portion of the Big Hole Valley, ten miles west of Wisdom, Montana on state highway 43.

Elevation: The Battlefield is topographically diverse. Mountain slopes occupy 42 percent of the area and range from 1860m (6100 ft.) to 2100m (6900 ft.) in elevation. Bench land occupies about 24 percent of the site and the flood plain formed by the North Fork of the Big Hole River comprises the remaining 34 percent of the Battlefield.

Climate: Summers are generally cool and breezy, with impressive mosquito populations in June and early July. Summer thunderstorms are not uncommon. Winters are frigid with deep snow. 30-year (1971-2000) climate data collected in Wisdom, Montana, show that the site is quite dry, with mean annual precipitation only totaling 30 cm (12 in) (Western Regional Climate Center 2003). January and July 30-year mean maximum and minimum temperatures are 27 and 1.5 degrees F^o and 77 and 37 degrees F^o, respectively (Western Regional Climate Center 2003).

General Description: The site contains sagebrush steppe (*Artemisia* spp.), lodgepole pine (*Pinus contorta*) forest, small groves of quaking aspen (*Populus tremuloides*), and a rich riparian corridor bordering the Big Hole River that contains potential spawning and rearing habitat for the sensitive arctic grayling (*Thyallus arcticus*).

Flora: The mountain slopes of the Battlefield are vegetated principally by conifers. Four major vegetation types were identified by Pierce (1982) for the mountain slopes; forest, forest ravine, sagebrush steppe, and gramanoid steppe. The major habitat type within the forest vegetation type is lodgepole pine/pinegrass (*Pinus contorta / Calamagrostis rubescens)*. Douglas-fir (*Pseudotsuga menzeisii*) and ponderosa pine (*Pinus ponderosa*) are scattered along the forest edge. Forest ravine comprises less than 3 percent of the area of mountain slopes. Approximately 20 percent of the mountain slope within the Battlefield boundary is comprised of sagebrush steppe with big sagebrush/Idaho fescue (*Artemisia tridentate / Festuca idahoensis)* as the primary habitat type.

The flood plain contains three major vegetation types: willow, graminoid, and aquatic. Fifty percent of the flood plain is dominated by willow (*Salix* spp.) species. The graminoid community comprises about 47 percent of the floodplain and is described by Pierce (1982) as a tufted hairgrass/sedge (*Deschampsia caespitosa / Carex)* habitat type. The North Fork branch of the Big Hole River runs through the flood plain in a northeasterly direction and comprises 3 percent of the flood plain forming the aquatic habitat. The floodplain supports a population of camas lily (*Camassia quamash*). This species is an important cultural resource as well as a unique component of the natural vegetation in the Battlefield. Camas is a traditional food crop for the Nez Perce people. It is a facultative wetland species that is at risk in areas where floodplain hydrology is altered by irrigation.

The benchland is divided into two vegetation types. Approximately 60 percent of the landform was grassland of the Idaho fescue/bluebunch wheatgrass (*Festuca idahoensis / Agropyron spicatum*) habitat type. Shrubland makes up another 20 percent of the benchland with big sagebrush/Idaho fescue habitat type dominating. The remaining 20 percent of the bench is occupied by the visitor center, park housing, parking lots, roadways, and sewage lagoons.

<u>Fauna:</u> Two inventories of vertebrates have been conducted at Big Hole NB (Van Sickle 1987, Strobel et al. (2003a). 83 species of birds, 31 species of mammals (excluding bats), six species of fish (although other fish have been found more recently), two reptiles, and two amphibians. Bats have not yet been inventoried. Elk (*Cervus elaphus*) hunting in the surrounding area is a source of revenue for adjacent communities in the fall. The Big Hole valley is an internationally renowned fly fishing destination. The arctic greyling is particularly unique and important vertebrate in the Big Hole valley, although it is not yet clear how much use the reach of the North Fork in the Battlefield receives from this species. The Big Hole valley is one of the last strongholds of this species in the lower 48 states.

<u>Mammals:</u> Big Hole Battlefield's willow-dominated riparian area is prime year-round habitat for beaver (*Castor canadensis*) and moose (*Alces alces*). A large elk herd also uses the area and gray wolves (*Canis lupus*) periodically pass through the park. Van Sickle (1987) completed a survey that documented 36 species of mammals that occurred on the battlefield site. Along with this survey Van Sickle (1987) also identified 30 species of mammals that were not found on the Battlefield but are potentially present in the park. The University of Idaho Department of Fish and Wildlife Resources conducted an inventory in 2002 under a cooperative agreement with the National Park Service Upper Columbia Basin Network. A total of 31 mammals, representing 88% of the expected list, were confirmed in the battlefield in 2002 (Strobel et al. 2003a). One confirmed species, the gray wolf, is listed as Threatened under the Endangered Species Act and as a “species of special concern” by the Montana Natural Heritage Program.

Birds: A survey of vertebrates at Big Hole (Van Sickle 1987) listed 90 species of birds. Results of bird surveys conducted in 1999 by Rita Dixon from the University of Idaho documented 83 species of birds at Big Hole (Dixon 2004).

Fish: Six species of fish were found in the North Fork of the Big Hole River during a survey conducted in 1987. The fish found were typical of low gradient reaches of high mountain streams. Mottled sculpins (*Cottus bairdi*) were the most abundant species captured and were found in every habitat. Other abundant species included white sucker (*Catostomus commersoni*), burbot (*Lota lota*), mountain whitefish (*Prosopium williamsoni*), and brook trout (*Salvelinus fontinales*). A relatively uncommon species present in the North Fork was the longnose dace (*Rhinichthys cataractae*).

Herptofauna: Two species of reptiles and two species of amphibians were found on the Big Hole National Battlefield during 1987 and confirmed again in 2002 (Strobel et al. 2003, Van Sickle 1987). A total of 4 herptofauna, representing 100% of the expected list, were confirmed in 2002. Wandering garter snakes (*Thamnophis elegans vagrans*) were the most abundant reptile and were found throughout the Battlefield, with the exception of the coniferous forest. A den was located in the rock abutment under the North Fork bridge during the 1987 survey. Fifteen to twenty snakes were observed sunning at this location. Two red-sided gartersnakes (*Thamnophis sirtalis parietalis*) were captured in 1987, both of which were found on the flood plain. Columbia spotted frogs (*Rana luteiventris*) were abundant on the flood plain during this same survey. The backwater pools associated with the beaver dam provided excellent habitat for spotted frog tadpoles. Two western toads (*Bufo boreas*) were found on the flood plain during 1987. No tadpoles were encountered, however one adult captured in late May 1987 appeared to be laden with eggs. One confirmed species, the western toad, is listed by the Montana Natural Heritage Program as a "species of special concern".

Unique Features and Species of Special Concern: No inventory has been conducted in the park to determine the presence of endangered, threatened, or rare species. Some have been seen on park lands and waters, such as Montana arctic grayling in the North Fork of the Big Hole River.

Resource Management Concerns

Exotic Plant Species: The spread of exotic and noxious weeds continues to be the major natural resource issue at Big Hole National Battlefield. In the past, local weed control districts have made requests of the park to control its infestations of yellow star-thistle (*Centaurea solstitialis*) and Scotch thistle (*Onopordum acanthium*), field bindweed (*Convolvulus arvensis*), poison hemlock (*Conium maculatum*), and other weed species. On-going control efforts are primarily limited to mechanical (and some herbicide) treatments.

Historic Vegetation Restoration: Restoration of the historic landscape of 1877 has been the focus of some interest over the last 20 years or so (Big Hole RMP 1987, Pierce 1982). At Big Hole, the exclusion of the natural fire regime appears to have altered forest succession. Lodgepole pine is expanding down slope into the steppe area adjacent to the "siege" area. This is a threat to the historic viewshed of the Battlefield and has some potential ecological ramifications as well.

In 1987 trees were removed on about 10 acres to restore the "bald" areas on the slopes above the battlefield. Prescribed fire was also used in 1986, 1988, 1993, 1997, 1998, and 1999 in the restoration of the natural system. More recent concern has been raised over the old irrigation canals that run across the monument on the east side of the battlefield below the visitor center. Water rights of downstream private lands will preclude any attempt to have these canals discontinued and removed. Currently, the canals are unlined and leak, allowing for narrow strips of green riparian vegetation to develop horizontally across the east slope of the battlefield. As with the lodgepole pine expansion, this has both viewshed and ecological ramifications. Future solutions may include lining or re-engineering the canals. Finally, concern is also growing over the impacts the access road and dike supporting the trail that leads to the "seige" area may be having on the natural meander course of the North Fork Big Hole River. Other hydrologic and ecological issues may also be related to this. Because of Big Hole's unique historic experience, altered flow and channel morphology not only cause natural resource problems such as bank erosion and degraded water quality through sedimentation. There is also concern that grave sites will also be exposed.

UCBN park document(s) used in this park description:
Big Hole National Battlefield Resource Management Plan, 1987.

CITY OF ROCKS NATIONAL RESERVE (CIRO)

Size: 5,708 hectares (14,107 acres)

Designation Date: 1988

Park History and Purpose: Beginning in 1843, City of Rocks was a landmark for emigrants on the California Trail and Salt Lake Alternate Trail and later on freight routes.

The area's historical and geological values, scenery, and opportunities for recreation led to its designation as City of Rocks National Reserve in 1988. This unit of the National Park System is managed cooperatively by the National Park Service and the Idaho Department of Parks and Recreation. The site is replete with high scenic granite spires and sculptured rock formations. It is a nationally recognized climbing destination. The reserve contains numerous small riparian zones tucked into the granite canyons and contains a diversity of vegetation cover types that are representative of the high elevation areas of the northern Great Basin.

Location: City of Rocks National Reserve lies southwest of the town of Almo in southcentral Idaho.

Elevation: The elevation of the Reserve ranges from 5,650 feet where Circle Creek meets the east boundary of the Reserve to 8,867 feet at Graham Peak, in the northern portion of the park.

Climate: City of Rocks is located in southern Idaho on the northern edge of the Great Basin. Outdoor recreation can be pleasant from April through October. Summers are generally dry. Weather data obtained from a station in Malta, Idaho, 27 miles from the Reserve, show 30-year mean annual precipitation to be 11 inches (Idaho State Climate Service 2003). Most precipitation falls in winter and spring. Summer temperatures range wildly with nighttime lows occasionally approaching freezing and midday highs nearing 100° F. July and August also experience afternoon thundershowers.

Flora: One or the reserve's most notable qualities is its large degree of biological diversity concentrated in a relatively small area. The great variety of textures, colors, and shapes in the natural landscape contributes considerably to the reserve's scenic quality. Intense grazing, dryland farming, and other events associated with the settlement of the area have reduced the diversity of the natural landscape by causing successional shifts in plant communities toward a dominance of woody perennial and alien annual herbs in many areas of the reserve.

The range of elevations within the compact area of the Reserve combines with other factors to create varied patterns of vegetation and wildlife habitat. At high elevations the forest patches contain Douglas fir, subalpine fir (*Abies lasiocarpa*), and limber pine (*Pinus flexilis*). Middle elevation forests consist of quaking aspen, mountain mahogany (*Cercocarpus ledifolia*), and cottonwood (*Populus* spp.). Sagebrush, pinyon pines (*Pinus monophylla*), and juniper (*Juniperus* spp.) dominate lower elevations. The Reserve boasts Idaho's tallest, and only, pinyon pines, at more than 55 feet. The nuts of the trees provide important proteins and fats for wildlife. Recent discovery of an outbreak of the pinyon *Ips* beetle (*Ips confusus*) at CIRO has presented a new and emerging threat to the pinyon-juniper vegetation. Both Rocky Mountain and Utah juniper are present in the monument (*J. scopularum* and *osteosperma*, respectively). In addition to the trees, spring and summer displays of wildflowers can be spectacular. Over 450 plant species have been recorded at the City of Rocks (John 1995).

Fauna: Part of Idaho's Minidoka Bird Refuge, the City of Rocks is home to eagles, falcons, vultures, hawks, hummingbirds, jays, sparrows, doves, and the state bird, the mountain bluebird (*Sialia currucoides*). Among the mammals that live within the park are elk, mule deer (*Odocoileus hemionus*), mountain lions (*Felis concolor*), coyotes (*Canis latrans*), badgers (*Taxidea taxus*), bobcats (*Felis rufus*), porcupines (*Erethizon dorsatum*), ground squirrels, and bats. Thirty-five species of mammals were confirmed in the Reserve during 2003 (Madison et al. 2003a). The cliff chipmunk (*Tamias dorsalis*), a "peripheral species" in Idaho, was found to be common in the area and the Reserve appears to support a relatively large population of this species. The spotted bat (*Euderma maculatum*) was confirmed in the Reserve in 2003. This species is listed as a species of special concern by the state of Idaho and is poorly known in the state. The hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), and pallid bat (*Antrozous pallidus*) were also confirmed in the Reserve for the first time during the 2003 inventory. The deer mouse (*Peromyscus maniculatus*) and the great basin pocket mouse (*Perognathus parvus*) were the two most abundant mammals represented in trapping results. The pinyon mouse (*Peromyscus truei*) was reconfirmed in the Reserve for the first time since an unvouchered report was made in 1967. City of Rocks is at the northern limit of the range for this unique species and the voucher specimen for this species collected in 2003 may represent a significant range extension for Idaho. In March of 2003, a ringtail (*Bassariscus astutus*) was found dead in the Castle Rocks area of the Reserve by Idaho Department of Fish and Game personnel. This was the first record of the species in Idaho and also represents a significant northward range extension. The status of this unique and secretive species in the Reserve should be further evaluated in the future.

Two species of lizards were observed during a herpetological inventory conducted in 2001, including the common sagebrush lizard (*Sceloporus graciosus*) and the western skink (*Eumeces skiltonianus*). Four species of snakes were observed including the rubber boa (*Charina bottae*), the striped whipsnake (*Masticophis taeniatus*), the gophersnake (*Pituophis catenifer*), and the western terrestrial gartersnake (*Thamnophis elegans*). The common sagebrush lizard was the most widespread and abundant species with 100 observations throughout the study area accounting for 70% of the total observations. Terrestrial Gartersnakes were the most abundant snake species detected with 33 observations accounting for 23% of the total observations. The boreal chorus frog (*Pseudacris maculata*) was the only amphibian species detected with 1 observation accounting for only 0.6% of the total observations (Shive and Peterson 2001).

<u>Unique Features and Species of Special Concern:</u> Information is limited for rare or species of special concern and their important habitats within the reserve.

Many rocks in the reserve provide essential habitat to some species that are sensitive to human activity. The rock cliffs provide important nesting habitat for various species of raptors, including the ferruginous hawk (*Buteo regalis*), a candidate threatened or endangered species. The cracks, crevices, and caves may be important roosting habitat for as many as six species of bats, including Townsend's big-eared bat (*Corynorhinus townsendii*), also a candidate species.

Plants that have been identified as species of special concern include Narrow-leaved Indian Paintbrush (*Castilleja angustifolia var. flavescens*), Simpson's Hedgehog Cactus (*Pediocactus simpsonii var. robustior*), and Kruckeberg's swordfern (*Polystichum kruckebergii*).

There are no federally listed threatened or endangered species in the reserve. However, ferruginous hawks and Townsend's big-eared bats, category 2 (candidate) species, do occur in the reserve. Ferruginous hawks and Townsend's big-eared bats and their important critical habitats should be strictly protected. Other species identified by the state as rare or sensitive and possible occurring at CIRO include the cliff chipmunk, Pallid bat, Pinyon mouse, and Greater sage grouse (*Centrocercus urophasianus urophasianus*).

<u>Resource Management Concerns</u>

<u>Rare and Species of Special Concern Inventory:</u> It was determined in the Comprehensive Management Plan for CIRO that the reserve should inventory all federal and state listed threatened, endangered, rare, declining, sensitive, or candidate species native to and present the reserve along with their critical habitats. These species would be given special consideration in all future planning activities and in management of special uses and activities such as grazing and recreation, including climbing. Species of special concern would be periodically monitored to ascertain the health of each identified population.

<u>Recreation Use:</u> City of Rocks offers scenic walks near the historic California Trail and opportunities for wildlife watching, photography, world-class technical rock climbing, mountain biking, hiking, horseback riding, ice climbing, cross country skiing, snowmobiling, snowshoeing, picnicking, and camping near rock formations. High visitor use is attributed to

excellent rock climbing opportunities. Impacts on natural resources at CIRO due to recreational use are a management concern.

Many rocks in the reserve provide essential habitat to some species that are sensitive to human activity. To ensure protection of sensitive cliff-dwelling species their habitat should be inventoried and important habitat monitored seasonally. Efforts would be directed primarily at protecting ferruginous hawks, golden eagles (*Aquila chrysaetos*), red-tailed hawks (*Buteo jamaicensis*), prairie falcons (*Falco mexicanus*), and Townsend's big-eared bat.

In recent years an increase in vegetative disturbance in the reserve has been attributed to an increase in recreational activities. The overuse of the land in some areas of the reserve has caused the loss of both vegetative cover and soil.

<u>Exotic Plant Species:</u> Many introduced plant species exist within the reserve. Some are a threat to resources; for example, halogeton is toxic to livestock and wildlife. Invasive plant species should be eradicated or controlled if they threaten to spread or compete with reserve resources and if control is feasible.

Canada thistle (*Cirsium arvense*) was found to be the most widespread noxious weed at City of Rocks (Monello and Wright 1998). Poison hemlock was the only other noxious weed found within the park boundary. John (1995) found spotted knapweed (*Centaurea maculosa*) and field bindweed within the reserve. In 2003, a total of 790 acres were surveyed within City of Rocks National Reserve (Prather 2003a). The acres surveyed represented sites targeted for survey and did not encompass the entire park. Field bindweed was the most widely distributed species. Most species were located on fewer than 5 acres. Of the species with greater than 1 acre total infested, salt cedar (*Tamarix ramosissima*) is by far the biggest concern.

<u>Grazing:</u> Grazing over the years has caused an increase in the density of woody plants and their expansion into new areas of the reserve. Increasing woody plant cover, especially sagebrush, has served to confine livestock grazing to less and less productive area over time, resulting in non-native plant species that are more resistant to livestock grazing.

Various techniques could be used involving fire and vegetation management to restore the range to more natural vegetative communities. For example, some basin areas now covered with monotypic stands of sagebrush and nonnative grasses could be managed toward a natural community of native perennial grasses and widely dispersed sagebrush. Protecting the natural vegetative communities would increase forage for both livestock and wildlife, provide better soil protection from erosion, and support a greater diversity of wildlife.

<u>Wetland Inventory:</u> It was determined in the Comprehensive Management Plan for CIRO that a wetland inventory, monitoring, and protection program should be developed (CIRO CMP 1994). This program should include a detailed onsite evaluation of all wetlands on the reserve. The study will determine the location, condition, threats to, and ecological function of all wetlands. The data will be used to monitor and mitigate impacts, including those caused by grazing.

UCBN park document(s) used in this park description:
City of Rocks Comprehensive Management Plan, 1994.

CRATERS OF THE MOON NATIONAL MONUMENT AND PRESERVE (CRMO)

Size: 190,081 hectares (469,711 acres)

Designation Date: 1924

Park History and Purpose: The Craters of the Moon National Monument was established on May 2, 1924 (Presidential Proclamation 1694), for the purpose of protecting the unusual landscape of the Craters of the Moon lava field. This "lunar" landscape was thought to resemble that of the Moon and was described in the Proclamation as "weird and scenic landscape peculiar to itself." The unusual scientific value of the expanded monument is the great diversity of exquisitely preserved volcanic features within a relatively small area. The expanded monument includes almost all the features of basaltic volcanism, including the craters, cones, lava flows, caves, and fissures of the 65-mile-long Great Rift, a geological feature that is comparable to great rift zones of Iceland and Hawaii. It comprises the most diverse and geologically recent part of the lava terrain that covers the southern Snake River Plain, a broad lava plain made up of innumerable basalt lava flows that erupted during the past 5 million years.

Since 1924, the monument has been expanded and boundary adjustments made through four presidential proclamations issued pursuant to the Antiquities Act (34 Stat. 225, 16 U.S.C. 431). Presidential Proclamation1843 of July 23, 1928, expanded the monument to include certain springs for water supply and additional features of scientific interest. Presidential Proclamation 1916 of July 9, 1930, Presidential Proclamation 2499 of 18, 1941, and Presidential Proclamation 3506 of November 19, 1962, made further adjustments to the boundaries. In 1996, a minor boundary adjustment was made by section 205 of the Omnibus Parks and Public Lands Management Act of 1996 (Public Law 104-333, 110 Stat. 4093, 4106).

A Proclamation dated November 9, 2000 enlarged the boundary to assure protection of the entire Great Rift volcanic zone and associated lava features, all objects of scientific interest. The Federal land and interests in land reserved consist of approximately 661,287 acres. The Craters of the Moon, Open Crack, Kings Bowl, and Wapi crack sets and the associated Craters of the Moon, Kings Bowl, and Wapi lava fields constitute this volcanic rift zone system. Craters of Moon is the largest basaltic volcanic field of dominantly Holocene age (less than 10,000 years old) in the conterminous United States. Each of the past eruptive episodes lasted up to several hundred years in duration and was separated from other eruptive episodes by quiet periods of several hundred years to about 3,000 years. The first eruptive episode began about 15,000 years ago and the latest ended about 2,100 years ago.

Craters of the Moon holds the most diverse and youngest part of the lava terrain that covers the southern Snake River Plain of Idaho, a broad plain made up of innumerable basalt lava flows during the past 5 million years. The most recent eruptions at the Craters of the Moon took place about 2,100 years ago and were likely witnessed by the Shoshone people, whose legend speaks of a serpent on a mountain who, angered by lightening, coiled around and squeezed the mountain until the rocks crumbled and melted, fire shot from cracks, and liquid rock flowed from the fissures as the mountain exploded. The volcanic field now lies dormant, in the latest of a series of quiet periods that separate the eight eruptive episodes during which the 60 lava flows and 25 cinder cones of this composite volcanic field were formed. Some of the lava flows traveled distances of as much as 43 miles from their vents, and some flows diverged around areas of higher ground and rejoined downstream to form isolated islands of older terrain surrounded by new lava. These areas are called "kipukas."

The kipukas provide a window on vegetative communities of the past that have been erased from most of the Snake River Plain. In many instances, the expanse of rugged lava surrounding the small pocket of soils has protected the kipukas from people, animals, and even exotic plants. As a result, these kipukas represent some of the last nearly pristine and undisturbed vegetation in the Snake River Plain, including 700-year-old juniper trees and relict stands of sagebrush that are essential habitat for sensitive sage grouse populations. These tracts of relict vegetation are remarkable benchmarks that aid in the scientific study of changes to vegetative communities from recent human activity as well as the role of natural fire in the sagebrush steppe ecosystem.

The Kings Bowl lava field and the Wapi lava field are included in the enlarged monument. The Kings Bowl field erupted during a single fissure eruption on the southern part of the Great Rift about 2,250 years ago. This eruption probably lasted only a few hours to a few days. The field preserves explosion pits, lava lakes, squeeze-ups, basalt mounds, and an ash blanket. The Wapi field probably formed from a fissure eruption simultaneously with the eruption of the Kings Bowl field. With more prolonged activity over a period of months to a few years, the Wapi field formed a low shield volcano. The Bear Trap lava tube, located between the Craters of the Moon and the Wapi lava fields, is a cave system more than 15 miles long. The lava tube is remarkable for its length and for the number of well preserved lava-cave features, such as lava stalactites and curbs, the latter marking high stands of the flowing lava forever frozen on the lava tube walls. The lava tubes and pit craters of the monument are known for their unusual preservation of winter ice and snow into the hot summer months, due to shielding from the sun and the insulating properties of the basalt.

<u>Location:</u> The Craters of the Moon National Monument and Preserve is located in central Idaho, approximately 160 miles east of Boise

<u>Elevation:</u> Elevations in the monument range from 1,625 meters to 2,355 meters. The tallest cinder cone, Big Cinder Butte, rises more than 200 meters above the surrounding plain.

<u>Climate:</u> The climate is semi-arid, with hot and dry summers and cold and wet winters. Winter snows comprise most of the annual precipitation in the monument. Snow pack usually lasts most of the winter. The 30-year mean annual precipitation is 15 inches in the north (CRMO weather station data) and less than 10 inches in the south (Minidoka Dam, weather station data). The average July maximum temperature is 84 degrees fahrenheit and average January minimum temperature is 10 degrees degrees fahrenheit (CRMO weather station data). Surface temperatures on the lava flows can reach 170 degrees fahrenheit during summer heat and winter temperatures frequently remain below freezing for long periods.

General Description: Although a desolate looking place, the park thrives with wildlife. More than 350 species of plants and 43 mammals can be found in the park and more than 160 different species of birds have been seen here.

Flora: Twenty-six vegetation types, containing over 300 native species, have been identified within Craters of the Moon. These vegetation types can be combined into eight major categories:

Cinder garden/lava flows: 70.1% - Areas of low total plant cover. Common species include dwarf buckwheat (*Eriogonum. ovalifolium var. depressum*), dwarf monkeyflower (*Mimulus nanus*), bitterroot (*Lewisia rediviva*), tansybush (*Chamaebatiaria millefolium)*, mockorange (*Philadelphus lewisii*), desert parsley (*Lomatium*), sandberg bluegrass (*Poa sandbergii*), rubber rabbitbrush (*Chrysothamnus nauseosus*), mountain big sagebrush (*Artemisia tridentate vaseyana*), needle grass (*Stipa spp.*), and Indian rice grass (*Oryzopsis hymenoides*).

Sagebrush associations: 19.9% - five species of sagebrush occur in the monument: mountain big sagebrush, big sagebrush, low sagebrush (*Artemisia arbuscula*), early low sagebrush, and three-tip sagebrush (*Artemisia tripartitia*). Common plants in association with sagebrush include bluebunch wheatgrass, sandberg bluegrass, needle grass, cheat grass (*Bromus tectorum*), and Idaho fescue.

Limber Pine associations: 7.1% - antelope bitterbrush (*Purshia tridentata*) is the main shrub in these areas.

Bitterbrush associations: 2.6% - other common species in these areas include rubber rabbitbrush, wax current (*Ribes cereum*), great basin wildrye (*Elymus cinereus*), arrowleaf balsamroot (*Balsamorhizza sagitatta*), and buckwheats.

Riparian: 0.1% -This type is located along streams in the North End. Tree species include quaking aspen, black cottonwood (*Populus trichocarpa*), mountain alder (*Alnus incana*), and bog birch (*Betula glandulosa*). There is a thick tall forb component including cow parsnip (*Heracleum lanatum*), bigsting nettle (*Urtica dioica*), and small-leaf angelica (*Angelica pinnata*).

Douglas-fir/Mountain Snowberry: 0.1% - found on steep, north-facing slopes and along Little Cottonwood Creek.

Grasses: 0.08% - the predominate grasses are bluebunch wheatgrass, Idaho fescue, sandberg bluegrass, and Great Basin wildrye.

Upland Quaking Aspen: 0.1% -Most common on upland sites in the North End. Understory is composed of mountain snowberry (*Symphoricarpos albus*), willow, forbs, and grasses.

The 1962 proclamation added Carey Kipuka to the Monument because of the scientific value of the sagebrush-grassland association.

In 1989, Carey Kipuka and portions of the North End of the Monument were nominated for inclusion in the National Natural Landmark System as representative of the Columbia Plateau Natural Region, Low Sagebrush Theme, Low Sagebrush/Idaho Fescue Subtheme. The National Natural Landmark Evaluation report states that these areas are "outstanding examples" and are "nationally significant".

Carey Kipuka was designated a Research Natural Area in 1993.

<u>Fauna:</u> Wildlife resources are abundant and varied. Approximately 50 species of mammals and 159 species of birds have been recorded at Craters of the Moon. A study conducted in the 1960s recorded over 2,000 species of invertebrates. A systematic inventory of reptiles and amphibians has been conducted and a report is in progress. The available information indicates that eight reptile species and two species of amphibians have been observed (CRMO RMP 1992).

Exotic species present in the monument include european starling (*Sturnella vulgaris*), chukar (*Alectoris chukar*), gray partridge (*Perdix perdis*), rock dove (*Columba livia*) and european house sparrow (*Passer domesticus*).

Several species were extirpated prior to the establishment of the monument: grizzly bear (*Ursus arctos*), wolf, and bison (*Bison bison*). The bighorn sheep (*Ovis canadensis*) is also thought to be extirpated, however a ewe was recorded in the Devils Orchard area in 1990. Porcupines were common in the monument in the 1920s and 1930s, however no live individuals have been documented since 1980 and only four were observed in the twenty years prior to 1980.

Mammals: Significant vertebrate predators in the monument are coyote, red fox (*Vulpes vulpes*), mountain lion, bobcat, black bear (*Ursus americanus*), badger, and long-tailed weasel (*Mustela frenata*).

Mule deer, elk, and pronghorn (*Antilocapra americana*) are important large herbivores at Craters of the Moon. The Craters mule deer herd has an unusual dual summer range within the park.

Three subspecies of mammals endemic to the Snake River Plain were first described at Craters of the Moon. They are pika (*Ochotona princeps goldmani*), yellow-pine chipmunk (*Eutamias amoenus craterieus*), and Great Basin pocket mouse (*Perognathus parvus idahoensis*).

A 2003 mammal inventory was conducted at CRMO and between the period 1990-2003, 45 species of mammals have been documented in or adjacent to the monument. One of those, the river otter (*Lutra canadensis*), was documented for the first time during the 2003 inventory. The moose, first documented in 1999, was observed in the monument at a greater rate in 2003 by monument and inventory staff. The deer mouse and the Ord's kangaroo rat (*Dipodomys ordii*) were the two most abundant species captured during inventory efforts in 2003 (Madison et. al. 2003b).

Birds: Hoffman (1988) sampled birds using a station index technique and reported 64 species. A checklist provided to park visitors indicates 156 species of birds potentially could be encountered.

Herptofauna: Two species of amphibians and eight species of reptiles were found on the monument (Hoffman 1988). Additional inventory work has been completed on amphibians and reptiles at CRMO by Idaho State University (Lee and Peterson 2003).

Unique Features and Species of Special Concern

Plants: Obsure phacelia (*Phacelia inconspicua*), a rare plant in Idaho, was documented in the North End of the monument during a rare plant survey. It has also been documented on BLM lands adjacent to the monument. This plant is a federal candidate species under the Endangered Species Act.

Wildlife: No federally listed threatened or endangered species occur at Craters of the Moon. Bald eagles (*Haliaetus leucocephalus*) are occasionally recorded flying across the monument, but do not reside here. Two former federal candidate species are found within the monument: blind cave leiodid beetle (*Glacicavicola bathyscoides*), and Townsend's big-eared bat. It is possible that the spotted bat, also an Idaho species of concern, occurs at Craters. Several other Idaho species of special concern have been observed: ferruginous hawk, merlin (*Falco columbarius*), and bobcat.

Resource Management Concerns

Preserving remnant stands of high quality sagebrush steppe habitat undisturbed by grazing has become increasingly important as habitat has been lost due to increased fire frequency and cheatgrass conversion. This has led to petitions being filed with the US Fish and Wildlife Service to list sage grouse as an endangered species. With the expansion of the monument, NPS concerns over management of sagebrush steppe habitat have increased significantly. NPS resource management staff indicates that they “don't know just what's out there”. Invasive weeds, including leafy spurge (*Euphorbia esula*) and knapweeds, just became a much bigger issue with significant infestations on lands added to the monument.

Another resource management concern on the horizon is the potential introduction of white pine blister rust (*Cronartium ribicola*) within the monument's limber pine stands. White pine blister rust is found in the Yellowstone region and the central Idaho mountains less than 60 miles from the monument. In the northern Rockies white pine blister rust has resulted in mortalities rates as high as 90% in limber and white bark pine.

Information is needed on the monument's water resources, especially the perennial ice in caves and deep crevices. It appears that many waterholes in the lava have dried up since they were reported in the 1920s.

The Federal Cave Resources Act of 1987 requires that cave resources be studied and significant caves be identified.

The U.S. Geological Survey predicts that volcanic activity will occur in the monument in the future. That agency has recommended installation of a seismic monitoring system to warn of impending eruptions.

Protection of geological resources is important because geology is the primary theme of Craters of the Moon. The fragile geological resources may appear to be sturdy, but they are affected by visitors; increased erosion of the spatter cones causes irreversible damage. Heavy use by visitors is contributing to erosion of the Inferno Cone trail. Illegal collection of specimens is another major problem.

UCBN park document(s) used in this park description:
Craters of the Moon Resource Management Plan, 1992.

HAGERMAN FOSSIL BEDS NATIONAL MONUMENT (HAFO)

Size: 1760 hectares (4351 acres)

Designation Date: 1988

Park History and Purpose: On November 18, 1988, Hagerman Fossil Beds National Monument was "established by Congress to: 1) preserve for the benefit and enjoyment of present and future generations the outstanding paleontological sites known as the Hagerman Valley fossil sites, 2) to provide a center for continuing paleontological research, and 3) to provide for the display and interpretation of the scientific specimens uncovered at such sites.

Hagerman Fossil Beds NM contains the largest concentration of Hagerman Horse fossils in North America. The Monument is internationally significant because it protects the world's richest know fossil deposits from a time period called the late Pliocene epoch, 3.5 million years ago. These plants and animals represent the last glimpse of time that existed before the Ice Age, and the earliest appearances of modern flora and fauna. It is also one of three National Park Service (NPS) units that includes ruts from the wagons traveling the Oregon Trail. The park also preserves pre-history and historical settlement resources.

Location: Hagerman Fossil Beds National Monument is located in south central Idaho on the western escarpment of Hagerman Valley. Hagerman Valley lies within the central Snake River Plain region of the eastern portion of the Columbia Plateau physiographic province. The Snake River flows west, then north, through this valley and scribes the eastern boundary of the Monument, a shoreline distance of approximately 7 miles. The entire length of the Snake River through the Monument is part of the Lower Salmon Falls Reservoir, the dam for which is located a short distance downstream from the monument. Another dam, the Upper Salmon Falls, is about 12 miles upstream from the Monument.

West of the Snake River, where the Monument is located, bluffs rise approximately 600 feet above the river. Much of this steep terrain is of badlands-type topography characterized by ridges, canyons, landslide scarps, and some flats. The bluffs are composed primarily of poorly consolidated, 3 to 4 million year old flood plain and stream deposits, volcanic ash and thin basalt flows that extend further northwest. Hagerman Valley formed about 15,000 years ago where the Bonneville Flood eroded between these sedimentary deposits and the basalt bedrock to the east. Vegetative cover is sparse, except around seeps and their intermittent streams, and is characterized by sagebrush steppe vegetation. Half a dozen landslides have occurred within the area of the Monument since the late 1970s, causing removal of vegetation, destruction of stratigraphy and paleontological sites, and steepening of some portions of the bluffs.

The western boundary of the Monument generally follows the crest of the bluffs. The plateau beyond the western boundary has been used as farmland since the 1970s, primarily for growing sugar beets, potatoes, winter wheat, and corn. The Monument consists of 4,350 acres, including 420 acres of currently State-owned land, and is 7 miles long and 2 miles wide at its widest reach. Average width is approximately 1 mile. The Monument can be accessed by boat across the Reservoir, or by land 5 miles southwest of the town of Hagerman. The Bell Rapids project road provides public vehicular access through the southern end of the Monument. Graveled farm roads access the northern end of the Monument.

A basalt cliff forms the eastern rim of the Hagerman Valley. The eastern rim averages 400 ft in elevation above the Snake River (2,800 ft above sea level) and is characterized by resistant basalt cliffs. A gently sloping bench two to four miles wide, stretches from the base of the cliff to the river. A site on the east side of the Snake River immediately north of the Bell Rapids boat dock with commanding a view of the bluffs has been purchased for the planned construction of a Research Center and Museum.

<u>Climate:</u> The climate in the region is semi-arid, with cool and dry winters and hot and dry summers. Rainfall patterns are variable in the region but most falls in the early spring and late fall. 30-year mean annual precipitation available from a weather station 9 miles north of Hagerman in the town of Bliss is 9.5 inches. Snowfall represents a small proportion of the winter precipitation but snow pack is ephemeral and rarely lasts more than a few days. 30-year January and July mean temperatures from Hagerman are 35 and 67 degrees Fahrenheit, respectively. 30-year mean January and July minimum and maximum temperatures are 19 and 53 degrees Fahrenheit and 40 and 94 degrees Fahrenheit, respectively. It is important to note that winter and summer temperature extremes frequently drop below freezing in the winter and above 100 degrees in the summer.

<u>General Description:</u> Very little quantitative documentation of Monument resources, other than paleontological resources, has been carried out. Six major landslides have occurred within the area of the Monument since the early 1970s, causing loss of scientifically significant strata, removal of vegetation, and forming dangerous vertical cliffs on the bluffs.

Wildlife and vegetation in the monument tend to be typical of the intermountain region and its high desert scrub and sagebrush communities. The Snake River provides habitat for migrating waterfowl, riparian vegetation, and fish species.

Vegetation in the Monument has been mapped for GIS vegetation types, but has never been ground surveyed. The Monument is surrounded by agricultural lands, as well as small towns, residences, and other developed areas. Grazing prior to establishment of the Monument in 1988 also undoubtedly contributed to alteration of soils, loss of native grasses, and establishment of non-native plant species.

Flora: The Monument consists predominantly of the sagebrush steppe communities common to much of south central Idaho. The steep slope of the bluffs west of the river provide an environment that contributes to the diversity of plant species. A riparian zone and local areas of marshland occur along the Reservoir. Wetlands exist along both Billingsley and Riley creeks.

Flora on the upland plateau was once a vast complex of Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) association. Most of this vegetation has been replaced by agricultural crops. Some of the Monument's west boundary areas were cleared and now support gray rabbitbrush (*Chrysothamnus nauseosus*), and introduced grasses and weeds.

Vegetation on the slopes is sparse in many areas due to aspect and slope. Greasewood (*Sarcobatus vermiculatus*) and rabbitbrush occur on more alkaline soils. Scattered four-wing saltbush (*Atriplex canescens*) occurs on more calcareous soils. Grasses are dominated by the non-native cheatgrass. Russian thistle (*Salsoa kali*) predominates on disturbed sites.

Riparian vegetation includes black cottonwood, bullrush (*Scirpus* spp.), and cattails (*Typha* spp.). Willows are most common in the vicinity of the dam and the falls to the north and south of the Monument. There are locally dense stands of the invasive Russian olive (*Eleagnus angustifolia*) along the shore, and purple loosestrife (*Lythrum salicaria*) and salt cedar is invading. Other aquatic vegetation includes as coontail (*Ceratophyllum demersum*), duckweed (*Lemna* spp.), watercress (*Rorippa nasturtium-aquaticum*), and pondweed (*Potamogeton* spp.). Algal mats are common in warm weather.

The Monument is also important to microbiotic plants, usually forming a soil crust or found on aging brush or rocks. A USGS-BRD botanist indicated that the exclusion of grazing makes portions of the Monument significant as a botanical preserve.

Fauna: The 2003 Hagerman Fossil Beds National Monument vertebrate inventory developed species lists and additional information on birds, non-volant mammals, and herpetofauna (Oelrich et.al. 2003). One hundred fifty-three bird species and twenty-six mammal species were confirmed. One of these species, the white-tailed antelope ground squirrel (*Ammospermophilus leucurus*) was not expected to occur in the monument. The pronghorn was confirmed in one location just outside of the monument. Of the 18 expected species of herpetofauna, 14 species were confirmed. A total of 4 amphibians and 10 reptiles were documented on the monument. The sagebrush lizard was found in one discrete location in the monument in 2003.

Mammals: Agricultural and residential development, as well as recreational activity, have altered the wildlife community of the Monument. The most visible species, when its population is high, is the black-trail jackrabbit (*Lepus californicus*). Other species include Piute and Belding's ground squirrels (*Spermophilus mollis, Spermophilus beldingi*), western harvest mouse (*Reithrodontomys megalotis*), wood rats (*Neotoma cinerea*), yellow-bellied marmots (*Marmota flavivventris*), and kangaroo rats (*Dipodomys* spp.). Predators include coyotes, badgers, striped skunks (*Mephitis mephitis*), weasels and mink (*Mustela* spp.), and an occasional bobcat. Small mammals are plentiful in the sparse desert vegetation as well as in the riparian habitats

Birds: One of the most abundant bird species is the non-native ring-neck pheasant (*Phasianus colchicus*). Adjoining agricultural lands provide nesting and brooding cover, while the river breaks are used for escape and winter cover. Modest populations of exotic gray partridge and chukar partridge occur in the area, with their populations depending on annual nesting success. California quail (*Callipepla californica*) are also common.

Waterfowl species are dominated by seasonal migrations. The state fish hatchery and game preserve in the Riley Creek marsh area serve as a resting area for migratory birds. Along with other species of dabbling and diving ducks, as many as 10,000 ducks may be present at a given time.

Golden eagles are seen during the winter season. The Idaho Power Company has completed some limited bird surveys in the Monument in preparation for their request of relicensing for the hydropower operations.

In 1991, the Nongame and Endangered Wildlife Program of the Idaho Department of Fish and Game (IDF&G) published a booklet "Idaho Bird Distribution: Mapping by Latilong," which contains wintering and breeding range information for bird species.

Fish: Fish reside in the small impoundments and the Snake River. The aquatic ecosystem is inextricably linked, through the riparian zone, with the terrestrial ecosystem. Species of fish in this stretch of the Snake River include rainbow trout (*Salmo gairdneri*), small-mouth bass (*Micropterus dolomieui*), chub (*Couesius plumbeus*), suckers (*Catostomus* spp.), and non-native carp (*Cyprinus carpio*). Sturgeon (*Acipenser transmontanus*), although once plentiful, are now rare.

Several stocks of Snake River salmon have been listed as threatened or endangered species. One landslide that occurred in 1993, upstream from the Monument, completely blocked the flow of the Snake River for a period of time. There is similar potential for landslides in the monument to impact habitats through which runs of threatened salmon pass.

Herptofauna: Fourteen reptile and amphibian species were found during the 2003 inventory and four species of reptiles that were expected to occur were not found (Oelrich et al. 2003). Undocumented species include the long-toed salamander (*Ambystoma macrodactylum*), northern leopard frog (*Rana pipiens*), longnose leopard lizard (*Gambelis wislizenii)*, and the western skink.

The pacific tree frog (*Hyla regilla*) was confirmed in this study based only on the calls that were heard at dusk. This species occurred in the cottonwood and Russian olive groves along the river.

The sagebrush lizard was found in one location in the monument. This species was found on the north end. University of Idaho biologists also encountered this species during a birding outing in the monument during 2001.

The long-toed salamander likely occurs in the monument and may be encountered in the future by looking under logs in moist woodlands in the monument and around the paleontology buildings and riparian area on the east side of the river.

The northern leopard frog has been documented near the Hagerman Valley in the past and is expected to occur here. However, this species is experiencing dramatic declines in distribution in the Pacific Northwest due to disease and competition from exotic species such as the bullfrog (*Rana catesbiana*). The longnose leopard lizard is expected to occur in the monument but invasion of cheatgrass and other annual grasses may be reducing the habitat quality of the monument for this species. This species depends on open tracts of loose soils in shrub steppe for foraging and the species has been lost from many areas where invasive vegetation has increased.

Unique Features and Species of Special Concern

Plants: The Idaho Conservation Data Center lists the following plant species of concern in the Monument and their sites need protection:

Giant helleborine	*Epipactis gigantea*
Packard's cowpie buckwheat	*Eriogonum shockley var. packardiae*
Owyhee mourning milkvetch	*Astragalus atratus var. owyheensis*

Mourning milkvetch (*Astragalus atratus var. inseptus (*C1*)), may be present and needs verification. Torrey's blazing star (*Mentzelia terreyi var. acerosa*) is no longer State listed but may require protection considerations.

Wildlife: Four federally listed threatened or endangered animals may occur in the monument: the bald eagle and three species of freshwater snails, the desert valvata (*Valvata utahensis*), the Snake River Physa (*Physa natricaria*), and the Bliss Rapids snail (*Taylorconcha serpenticola*). Surveys for endangered and threatened animals have not been conducted in the monument.

Paleontological Resources: The Hagerman fossil beds are located in fluvial and floodplain deposits along the eastern margin of the Glenns Ferry Formation. More than 500 fossil sites have been documented over a six-square mile area at different horizons within these sediments. Many fossil exposures have occurred in areas of ablation, where the wind has eroded the protective sedimentary cover. But the most well known discovery has been the Smithsonian Institution Horse Quarry, the largest single deposit of an extinct species of zebra-like horse ever found. Also preserved within the sediments is one of the most prolific and diverse deposits of Pliocene animals. Over 100 species of vertebrates, including 18 fish, 4 amphibians, 9 reptiles, 27 birds and 50 mammals have currently been identified, as well as freshwater snails and clams, and plant pollen.

Present in the Monument are carbonaceous paper shales with high amounts of plant debris that represent pond deposits. As of yet there have been no studies on these shales with regard to the macrobotanical material. Study of plants from these deposits should yield important information on the vegetation associated with pond environments. These shales also have the potential to produce insects.

Although not perfectly preserved, a log was discovered buried in the strata. Isotope studies on this wood should yield important data with regard to water associated with the living tree and related environmental and climatic information.

Resource Management Concerns

Aquatic Resources: Along the shoreline of the Monument, the flow of water through the reservoir may affect water quality, water temperature, and substrate; fish and other aquatic species; waterfowl and other water-associated bird species; native and non-native riparian plants, amphibians, and other species; and, in turn, upland species.

Restoration of Historic Vegetation: One of the resource management objectives stated in the Resource Management Plan is to re-establish native plant communities and associated ecological processes, such as disturbance regimes and soil processes. The strategy developed to meet this objective is to document existing and historical vegetation and to develop vegetation goals and a management plan to accomplish them.

Wildlife: One of the resource management objectives stated in the Resource Management Plan is to perpetuate natural diversity, abundance, and behavior of native wildlife species. A strategy to meet this objective includes an inventory of existing and extirpated species, coordination with other agencies, companies, and other interested parties in acquiring information and meeting mutual goals, and identification of species of special concern and their patterns and locations of habitat use.

Recreation Use: People currently visit the Monument for a variety of activities, primarily to see fossils, which unfortunately requires a guided tour by a Park Ranger. Limited number of staff does not provide much opportunity. As an alternative, staff has developed a self-guided driving tour, a historic trail tour, and a guide for the trail system. Trail uses include hiking, mountain biking, and horseback riding, all of which incorporate enjoyment of the open space. Other on-site uses include fishing and hunting. Adjacent uses in the reservoir include boating, jet-skiing, and other lake uses. In the future, as NPS facilities are developed and the Monument becomes more widely known, the number of people who are drawn to the Monument will increase. This diverse array of visitor activities may have a variety of impacts. No monitoring of visitor impacts is currently carried out.

Land Use Impacts: Pesticides and fertilizers are used in the agriculture that occurs in the region. These chemicals have the potential to affect water quality in wetlands and surface and subsurface waters.

Exotic Plant Species: One of the resource management objectives stated in the Resource Management Plan is to control the spread of non-native species and, where feasible, remove them from areas where they are already established. A strategy to meet this objective is to inventory and map vegetation species. This inventory would be followed by the application of IPM techniques to control and manage non-native species and a close coordination with counties and other agencies in management of non-native species.

Non-native plant species known to be present include Russian olive, Russian thistle, quackgrass (*Agropyron repens*), cheatgrass, blue mustard (*Chorispora tenella*), tansymustard (*Descurainia sophia*), tumble-mustard (*Sisymbrium altissimum*) and medusahead *(Taeniatherum caput-medusae*). These and other non-native species likely to be present impair the monument's native plant communities and ecosystem processes.

<u>UCBN park document(s) used in this park description:</u>
Hagerman Fossil Beds Resource Management Plan

JOHN DAY FOSSIL BEDS NATIONAL MONUMENT (JODA)

<u>Size:</u> 5688 hectares (14,056 acres)

<u>Designation Date:</u> 1974

<u>Park History and Purpose:</u> Within the heavily eroded volcanic deposits of the scenic John Day River basin is a well-preserved fossil record of plants and animals. This remarkably complete record, spanning more than 40 of the 65 million years of the Cenozoic Era (the "Age of Mammals and Flowering Plants") is world-renown. Authorized October 26, 1974, and established in 1975, this 14,000 acre park is divided into three widely separated units; the Sheep Rock Unit, Painted Hills Unit, and Clarno Unit. The monument's main headquarters is at the visitor center in the Sheep Rock Unit. There is also a park office located in John Day, Oregon.

The park's purpose is to identify, interpret, and protect the geologic, paleontological, natural, and cultural resources along the central and upper John Day River and to provide facilities that will promote and assist visitor recreational enjoyment and understanding of the same.

<u>Location:</u> John Day Fossil Beds National Monument consists of 14,056 acres in three noncontiguous units. Sheep Rock is the largest unit, located a few miles northwest of Dayville in Grant County. The next biggest unit is Painted Hills, lying 10 miles northwest of Mitchell in adjacent Wheeler County. Also in Wheeler County is the smallest unit, Clarno, roughly 20 miles southwest of Fossil. An administrative headquarters is located at the park's main visitor contact point, that being the Cant Ranch in the Sheep Rock Unit.

<u>Climate:</u> The extensive rain shadow cast by the Cascade Mountains and Ochoco mountains to the west dominates the climate of the monument. Winters are cool and dry and summers are hot and dry. Rainfall patterns are variable in the region but most falls in the early spring and late fall (Oregon Climate Service 2003). Thirty-year averages available from a weather station near the town of Dayville, 8 miles up the John Day River from the Sheep Rock Unit, show that total annual precipitation is approximately 11 inches (Oregon Climate Service 2003). Records from Mitchell, near the Painted Hills Unit, are similar, and the Clarno Unit may receive even less precipitation because of its low elevation (Oregon Climate Service 2003). Data from the rain gauge at the monument headquarters indicate that rainfall there has been below average in recent

years. The total precipitation in the Sheep Rock Unit for 2001 and 2002 was 10 and 6.5 inches, respectively (Ken Hyde, JODA, personal communication). In 2003, precipitation was higher, with a total of 11.5 inches recorded at Sheep Rock (Ken Hyde, JODA, personal communication). Snowfall represents a significant proportion of the winter precipitation but snowpack is ephemeral and rarely lasts more than a few days. Thirty-year January and July mean temperatures from Dayville are 36 and 71 degrees Fahrenheit, respectively (Oregon Climate Service 2003). Thirty-year mean January and July maximum and minimum temperatures are 45 and 90 degrees and 27 and 52 degrees, respectively (Oregon Climate Service 2003). It is important to note that winter and summer temperature extremes frequently drop below zero in the winter and above 100 degrees in the summer.

<u>Elevation:</u> Elevation in the monument ranges from approximately 1380 feet in the Clarno Unit, to a high point of approximately 4114 feet in the eastern boundary of the Sheep Rock Unit. The majority of the monument, including much of the Painted Hills, lies within 2000 to 2500 feet.

<u>General Description:</u>
<u>Sheep Rock</u>, towering 1,100 feet over the John Day River, gives its name to this unit. Wild big horn sheep and later a thriving domestic sheep ranch both occupied this landscape in the recent past. Meanwhile, the colorful layers of Sheep Rock represent a more distant time, approximately 28 to 25 million years ago. Then, the region was covered by deciduous forests, inhabited by three-toed horses, rhinos, oreodonts, saber-toothed cat-like animals, and lemur-like primates. The Sheep Rock Unit is home to the James Cant ranch house (built 1918), now the monument's visitor center. The visitor center features a fossil museum and is the administrative headquarters for the monument. A series of trails, outdoor exhibits, and overlooks are also available here.

The <u>Painted Hills Unit</u> is 3,132 acres of scenic beauty unique in the Pacific Northwest. Located 10 miles west of Mitchell, and 75 miles east of Bend, it is visited year around. Over 32,000 people visited the unit last year, with almost 10,000 of them hiking one or more of the unit's interpretive trails. Outdoor exhibits and a picnic area are also available for visitors here.

The yellows, gold, blacks, and reds of the Painted Hills are best seen in the late afternoon. Even after several visits, one may not see the same tone or hue as the claystones differ with ever-changing light and moisture levels. The colors of the hills are sublime. We like to think they even give the passing pronghorn or mountain lion pause to reflect. Most years, the peak days of wildflower season in late April to early May is spectacular.

The <u>Clarno Unit</u> is 1,969 acres in size and is located 18 miles west of the town of Fossil. It has hiking trails, exhibits, and a picnic area, and received over 12,000 visitors last year. The modern vegetation here is typical of Central Oregon's near-desert environment with a variety of grasses, sagebrush and juniper. The cliffs of the Palisades are the most prominent landform in the Clarno Unit. The Palisades were formed by a series of volcanic mudflows in a much different environment 44 million years ago. These mudflows, called lahars, preserved a great diversity of fossils. At that time, the Clarno volcanoes dominated a landscape covered by near-tropical forest, with approximately 100 inches of rain per year. Tiny four-toed horses, huge rhino-like brontotheres, crocodilians, and meat-eating creodonts roamed the ancient jungles.

Flora: The primary vegetation type in the monument is sagebrush steppe, consisting of sagebrush or shadscale and a variety of bunchgrasses. Moist alkaline flats support alkali-tolerant greasewood. Along the John Day River and tributaries that flow through the monument, vegetation consists of willows, cottonwoods, and a variety sedges and forbs.
Juniper woodlands are also an important vegetation type in the monument. Historically, juniper was restricted to rimrock and canyon bottoms protected from wildfire. Heavy grazing and fire suppression have allowed juniper to expand into deeper soiled steppe habitat.

Fauna: Because of its wilderness character, this region supports a great variety of wildlife species. In winter, seasonal changes force many birds and mammals to move from the mountains into the sagebrush semi-desert, where they find suitable habitat alongside the area's permanent residents.

Mammals: Large mammals present in the monument include coyote, mule deer, mountain lion, and bobcat. Smaller species include deer mouse, northern pocket gopher (*Thomomys talpoides*), Ord's kangaroo rat, Great Basin pocket mouse, western harvest mouse, montane vole (*Microtus montanus*), and bushy-tailed wood rat (*Neotoma cinerea*).

Forty-six species of mammals were confirmed in the monument during 2002 and 2003 and one of these, the bighorn sheep, was not expected to occur there. All 14 species of bats expected to occur in the monument were documented. The discovery of the spotted bat in all 3 units of the monument was particularly exciting since the species is virtually unknown in Oregon and is rare throughout its range (Rodhouse et al. 2004).

Birds: The numerous raptors here include red-tailed hawk, golden eagle, prairie falcon, American kestrel (*Falco sparverius*), great horned owl (*Bubo virginanus*), barn owl (*Tyto alba*), long-eared owl (*Asio otus*), and screech owl (*Otus kennicottii*). One-hundred forty-two species of expected birds have been confirmed in or adjacent to the monument. Thirteen additional species that were not expected were also recorded in the monument. The 2002-2003 inventory yielded the first record of the peregrine falcon (*Falco peregrinus*) for the monument (Rodhouse et al. 2004).

Herptofauna: A total of 5 species of amphibians and 12 species of reptiles were documented in the monument in 2002 and 2003. Only two expected species of herpetofauna, the pygmy short-horned lizard (*Phrynosoma douglasi*) and the rubber boa, remain to be confirmed. A unique and isolated population of western whiptail (*Cnemidophorus tigris*) lizards was found in the Foree portion of the Sheep Rock Unit (Rodhouse et al. 2004).

Unique Features and Species of Special Concern

Plants: Eight of the plant species found are considered rare or threatened (Youtie and Winward 1977). These plants included John Day milkvetch (*Astragalus diaphanus*), pauper milkvetch (*Astragalus misellus var. misellus*), yellow hairy paintbrush (*Castilleja xanthotricha*), John Day chaenactis (*Chaenactis nevii*), Henderson's lomatium (*Lomatium hendersonii*), barrel cactus (*Pediocactus simpsonii var. robustior*), crested tongue penstemon (*Penstemon eriantherus var. argillosus*) and belled cinquefoil (*Potentilla glandulosa var. cinquefoil*). A rare plant survey is in progress during FY 04.

Animals: Over 30 species of vertebrates listed as state or federal species of concern have been documented in the monument during recent inventories. However, only the bald eagle, bull trout, and steelhead are listed as threatened under the federal endangered species act.

Resource Management Concerns

Wildlife: The National Park Service presently lacks information to adequately assess the conditions of wildlife populations within the monument. Casual visual observations and information sharing with other agencies such as the Oregon Department of Fish and Wildlife suggests that the populations are stable and with no immediate threats. Recent efforts to improve riparian conditions within the monument are believed to be beneficial to wildlife dependent upon or utilizing those habitat types.

The deer population survey conducted in 1979 (Griffith 1980) concluded that there is a year-long resident population supplemented by a migratory wintering population present in the monument from November through April. Deer do not appear to make exclusive use of the monument as a refuge during hunting season, as extensive vegetation exists on adjacent lands. The temptation to harvest easily accessible deer results in a couple of poaching incidents in the monument each year. Control efforts for certain predators, such as coyotes and cougars, on adjacent lands are moderate to intense and any of these animals using the monument are vulnerable.

A raptor study was completed in 1977 which concluded that the present raptor population is not numerous due most likely to the lack of suitable habitat, particularly in the tree-less riparian areas (Janes 1977). Based upon examination of photographs taken in the 1800's and early 1920's, it doesn't appear that these sections of the river were always devoid of trees. The report makes recommendations for raptor habitat improvement within the monument, including tree plantings in riparian areas.

In 2003, a telemetry study located maternity roosts of pallid bats and western small-footed myotis (*Myotis ciliolabrum*) in and adjacent to the monument. This study determined that pallid bats are highly colonial in the monument and concentrated in the largest cliff complexes. Visitation may be impacting these colonies, as regularly traveled paths are located along the base and rim of some of these cliffs.

Fisheries: The National Park Service presently lacks information to adequately assess the condition of fish populations within the monument. Casual visual observations and information sharing with other agencies such as the Oregon Department of Fish and Wildlife, suggests that the populations are stable and with no immediate threats. Recent efforts to improve riparian conditions within the monument are believed to be beneficial to fish populations. Similar efforts by the Bureau of Land Management and private land owners along Bridge Creek and its major tributaries are similarly beneficial. Continuation of past agricultural practices such as year-around livestock grazing within riparian areas and clearing of all vegetation from the stream channels along the John Day River and Rock Creek above the monument likely threatens the condition of fish populations by raising temperatures and siltation in waters within the monument. An ongoing study by the University of Oregon, in cooperation with the U.S. Fish and Wildlife Service and ODF&W will provide a better understanding of the relationship between streamside vegetation and fish populations.

The Oregon Department of Fish and Wildlife does not regularly sample fish populations in any waters within the monument. The National Park Service needs to cooperate more closely with that department to determine the baseline condition of fish populations in river waters within the monument. Also, work underway by the University of Oregon on lower Rock Creek and the John Day River near its confluence with Rock Creek will provide some baseline information on fish populations. Ultimately extrapolation and qualified interpretation of existing data should provide a better assessment of the distribution and condition of aquatic populations in the monument.

<u>Vegetation:</u> Most of the monument lands have been subject for the past 100 years to livestock grazing and related agricultural uses. Subsequently, many of the native plants, including grasses, have been severely reduced in their distribution. Population diversity has been reduced as well. Exotic species such as cheat grass have replaced the native grasses and forbs.

Other introduced exotic species, such as knapweed, white top, and medusahead are present and spreading. Dalmation toadflax (*Linaria dalmatica*) and yellow star thistle (*Centaurea solstitialis*), particularly noxious plants, can also be found in the monument. The effect is an unnatural and unappealing scene. In the case of noxious plants, there are real and perceived threats to surrounding agricultural lands from the spread of these introduced plants. Past and current use of herbicides to control noxious plants within and adjacent to the monument theatens the well-being of other natural resources and processes.

Suppression of fires in and around the monument for the past 100 years has resulted in the proliferation of woody plants such as juniper and big sage, as well as annual grasses, contributing to a serious increase in fuel loads and further exacerbating the condition of native grasses and forbs.

Healthy remnants of native plant communities still exist within the monument. Removal of livestock grazing on most of the monument has removed the potential for overgrazing of these communities. However, the absence of wildfire has resulted in overgrowth of competing over-story vegetation and weakening the vigor of many native plants.

Within the historic zone of the monument, the agricultural fields are in poor condition. The irrigation water distribution system is the principal problem. Three hay fields totaling 57 acres have been offered for lease for hay production and livestock grazing but interest in leasing has been minimal. Also within the historic district is the remnant of a “Homestead orchard.” The remaining fruit trees in the orchard are old and weakening from age, disease, insects and lack of adequate care.

UCBN park document(s) used in this park description:
John Day Fossil Beds Resource Management Plan,

LAKE ROOSEVELT NATIONAL RECREATION AREA (LARO)

Size: 40,625 hectares (100,390 acres)

Designation Date: 1946

Park History and Purpose: In 1946 the Secretary of the Interior, by his approval of an agreement between the Bureau of Reclamation, the Bureau of Indian Affairs, and the National Park Service (NPS), designated the NPS as the manager for the Coulee Dam National Recreation Area. The area included Franklin D. Roosevelt Lake, the Reservoir formed behind Grand Coulee Dam, and the "freeboard" lands that where purchased at and above 1310’ elevation. Through over 50 years of changes, including a name change to Lake Roosevelt National Recreation Area in 1997, the NPS now manages approximately 47,438 acres of the 81,389 acres of total water surface, associated shoreline, and 12,936 acres of the 19,196 acres of total freeboard land. Also in 1990 two adjacent Indian Tribes were included in the Lake Roosevelt Cooperative Management Agreement with the other three agencies involved in the 1946 agreement. The Colville Confederated Tribe and the Spokane Tribe of Indians manage the remaining water surface and freeboard land.

The purpose and significance of LARO, as articulated in the park’s general management plan is as follows:

PURPOSE
- Provide opportunities for diverse, safe, quality, outdoor recreation experiences for the public.
- Preserve, conserve, and protect the integrity of natural, cultural, and scenic resources.
- Provide opportunities to enhance public appreciation and understanding about the area's significant resources.

SIGNIFICANCE
- It offers a wide variety of recreation opportunities in a diverse natural setting on a 154-mile-long lake bordered by 312 miles of publicly owned shoreline.
- It contains a large section of the upper Columbia River and a record of continuous human occupation dating back more than 9,000 years.
- It is contained within three distinct geologic provinces – the Okanogan Highlands, the Columbia Plateau, and the Kootenay Arc – all of which have been sculpted by Ice Age glaciation and catastrophic floods.

Location: Lake Roosevelt National Recreation Area (LARO) stretches 130 miles along the length of Lake Roosevelt located in north central Washington. The recreation area includes the lower reaches of many rivers and streams, including the Spokane and Kettle Rivers.

Elevation: 1310 feet

Climate: The southwestern portion of the recreation area is in the Columbia Plateau, which experiences a semi-arid climate and consists primarily of sagebrush steppe vegetation interspersed with agricultural lands. Thirty-year mean annual precipitation available from a weather station in the town of Coulee Dam is 11 inches (Western Regional Climate Center 2003). Thirty-year January and July mean temperatures from Coulee Dam are 26 and 72 degrees Fahrenheit, respectively while thirty-year mean January and July maximum and minimum temperatures are 32 and 22 degrees and 86 and 58 degrees, respectively (Western Regional Climate Center 2003). The northeastern portion of the recreation area is in the Okanogan Highlands, which experiences a cooler and wetter climate and consists primarily of pine forest. Thirty-year mean annual precipitation available from a weather station in the town of Northport is 20 inches (Western Regional Climate Center 2003). Thirty-year January and July mean temperatures from Northport are 25 and 69 degrees Fahrenheit, respectively while thirty-year mean January and July maximum and minimum temperatures are 32 and 21 and 86 and 51 degrees, respectively (Western Regional Climate Center 2003).

Flora: The vegetation at LARO fits primarily into three broad categories. These are steppe grasslands, shrub-steppe grasslands and transition forest (ponderosa pine). Other categories include riparian/wetland, mixed-conifer, lithosol areas, rocky outcrops, and actively eroded slopes. The southern third of the lake is bordered by often moderate to steep slopes with a northerly aspect. The toe of these slopes have sedimentary terraces with fairly steep down slope sides. These areas are vegetated with bunchgrasses, forbs, and shrubs. The common shrubs are big sagebrush, rabbitbrush, and antelope bitterbrush. Some soil types support Douglas fir and ponderosa pine in shaded aspects and microsites. The common grasses throughout the whole area, particularly the dry sites include bluebunch wheatgrass, Idaho fescue, sand dropseed (*Sporobolus cryptandrus*) and needle and thread grass (*Stipa comata*). The Northern two-thirds is either mountain slopes or larger terraces. Both the mountain slopes and the large terraces have sedimentary terraces at their toe with fairly steep sides. The middle third is predominantly ponderosa pine forests with associated grasses, forbs and shrubs. Common shrubs include antelope bitterbrush, snowberry (*Symphoricarpos oreophilus*), serviceberry (*Amelanchier alnifolia*), ocean spray (*Holodiscus discolor*), and wild rose (*Rosa* spp.). The upper third is similar to the middle section but has a little more moisture and in some places supports a mixed-conifer zone with Douglas fir and ponderosa pine. Other trees that occur include Western larch (*Larix occidentalis*), lodgepole pine, Western paper birch (*Betula papyrifera*), and grand fir (*Abies grandis*). The shrub species are similar to the middle third with the addition of buffalo berry (*Shepherdia canadensis*), and snowbrush ceanothus (*Ceanothus velutinus*). Pinegrass becomes more common in the northern third. The riparian zones, which are most well developed in the northern portion, are dominated by willows, alder, black cottonwood, water birch (*Betula occidentalis*), and the occasional western red cedar (*Thuja plicata*).

Fauna: Animals present at LARO are typical for the semi-arid temperate conditions and the resulting vegetation. Some species, such as deer, can be considered to be quite abundant. Little information is available regarding rare species present at LARO.

Given the linear nature of the national recreation area, terrestrial habitat for larger wildlife is somewhat limited. Although LARO is too narrow to provide all aspects of a large mammal's range and habitat, it does provide important habitat to some charismatic species. The two major examples would be white-tailed deer (*Odocoileus virginanus*) and mule deer and bald eagles. The Washington Department of Fish and Wildlife's Priority Habitats and Species program has listed areas along the Columbia River in LARO as important winter range for deer. For bald eagles, a threatened species, large ponderosa pine trees, and snags, provide critical nesting and roosting habitat. Moose and black bear are also occasionally seen in the park.

Hunting is permitted within LARO during established seasons. The Washington Department of Fish and Wildlife establishes the hunting seasons and related regulations. National Park Service and tribal rangers, state game agents, and county sheriffs enforce the hunting regulations.

Mammals: Common large mammal species using the area include whitetail and mule deer, coyote, bobcat, badger, and black bears. Less common large mammals present include elk, moose, and mountain lions. These larger species tend to move through the area in response to daily and seasonal migrations.

Medium-sized mammals found in the area include river otter, muskrat *(Ondatra zibethicus*), mink, raccoon (*Procyon lotor*), and striped skunk. In addition, bats, beaver, porcupine, mountain cottontail (*Sylvilagus nuttallii*), red squirrel (*Tamiasciurus hudsonicus),* Columbian ground squirrels (*Spermophilus columbianus*), chipmunks (*Tamias* spp.), and yellowbellied marmot.

Forty-one species of mammals were confirmed in or adjacent to the recreation area during an inventory conducted in 2003. A highlight of the 2003 inventory was the discovery of three species of shrews (family Soricidae). This group of cryptic mammals is frequently overlooked and is generally poorly known in the Pacific Northwest. The frequent sightings of the black bear and moose in recent years are also important (McCaffrey et al. 2003).

Birds: The abundance of water and small adjacent areas of riparian and wetland habitats attract an abundance of avian species. Lake Roosevelt is within the Pacific Flyway and serves as a resting area during migration. Resident and migratory birds common to the area include large populations of waterfowl, shorebirds, gallinaceous birds, pigeons, woodpeckers, hummingbirds, raptors, and passerines.

One hundred eighty-two species of birds were confirmed in or adjacent to the recreation area in 2003, including 2 species not expected to occur there (McCaffrey et al. 2003). Several species of raptors nest, roost or forage in the area. Among these are the osprey (*Pandion haliaetus*), golden eagle, bald eagle, red-tailed hawk, Northern harrier (*Circus cyaneus*), rough legged hawk (*Buteo lagopus*), American kestrel, prairie falcon, and peregrine falcon. Peregrine falcons have been reintroduced in LARO in an effort to restore a breeding population to the area. At present, no aeries are known to have been established within the Recreation Area, but individuals have been spotted utilizing the Recreation Area, and nests are documented south of the recreation area in Banks Lake. Owls include great-horned owl, Northern saw-whet owl (*Aegolius acadicus*), Western screech owl, short-eared owls (*Asio flammeus*), and barn owls.

Dozens of species of passerines use the area for foraging and nesting. The most common of these include swallows, finches, jays, chickadees (*Parus* spp.), ravens (*Corvus corax*), American crow (*Corvus brachyrhynchos*), black-billed magpies (*Pica pica*), Western meadowlarks (*Sturnella neglecta*), American robins (*Turdus migratorius*), sparrows, blackbirds, mourning doves (*Zenaida macroura*), pigeon and juncos (*Junco hyemalis*).

Common waterbirds include surface feeding ducks (mallards, pintails, teal, and golden eyes), diving ducks (redheads, coots, and buffleheads), western grebe (*Aechmophorus occidentalis*), coot (*Fulica americana*), lesser scaup (*Aythya affinis*), common merganser (*Mergus merganser*), common loon (*Gavia immer*), and Canada geese (*Branta canadensis*). Wading and shorebirds in the area include sandpipers, northern killdeer (*Charadrius vociferous*), great blue heron (*Ardea herodias*), as well as gulls (*Larus* spp.), common snipe (*Gallinago gallinago*), and yellowlegs (*Tringa* spp.).

Common gallinaceous birds include a combination of native and introduced species. Native species include ruffed grouse (*Bonasa umbellus*), and blue grouse (*Dendragapus obscurus*). Introduced species include the ring-necked pheasant, chukar, gray partridge, California quail, and wild turkey (*Meleagris pallavo*). The elimination of natural sagebrush and bunchgrass communities on adjacent lands has severely reduced populations of shrub-steppe dependent species. Elimination of fencerows by agriculture has reduced habitat utilized by native and introduced species.

<u>Herptofauna:</u> Sixteen species of herpetofauna were confirmed in or adjacent to the recreation area during an inventory conducted in 2003. Known reptiles and amphibians include the sagebrush lizard, short-horned lizard, western rattlesnake (*Crotalus viridis*), gopher snake, western garter snake, western toad, great basin spade-foot toad (*Spea intermontana*), pacific tree frog, and western painted turtle (*Chrysemys picta*). The rediscovery of the western toad in the southern portion of the recreation area was exciting, as this species is believed to be declining in many parts of its range (Corkran and Thoms 1996). The spotted frog was absent during spring searches in 2003, and may be extirpated in the Lake Roosevelt region due to increasing numbers of introduced gamefish and the bullfrog (Corkran and Thoms 1996, Ray Dashiell personal commuication).

<u>Fish:</u> Lake Roosevelt and its tributaries in the National Recreation Area support a varied fish community that today is considerably different from the native fish community of the early 1900's. The changes over time were caused by the introduction of nonnative species, habitat alterations such as water pollution, damming of rivers and reservoir drawdowns. Surveys in the 1990's have identified up to 30 species of fish in LARO. Seven of these species were found in low numbers, with many represented by only one individual in one survey out of eight. Biologists believe that these individuals may occasionally wash down from reservoirs and lakes upstream or are introduced by unauthorized human introductions. Of the 30 species detected 10 are not native to the Columbia River. The most abundant species include large-scale sucker (*Catostomus macrocheilus*), smallmouth bass, burbot, walleye (*Stizostedion vitreum*), kokanee

salmon (*Oncorhynchus nerka*), and rainbow trout. One other important species, because of its sensitive nature in the reservoir, is the white sturgeon.

Unique Features and Species of Special Concern

Plants: Surveys were initiated in 2003 for two State listed sensitive plant species. *Antennaria parvifolia*, Nuttall's pussy-toes and the *Oxytropis campestris var. columbiana,* Columbia crazyweed. Listed as sensitive and threatened by the Washington State Department of Natural Resources Natural Heritage Program, these species were known to exist at LARO. The only known patch of Columbia crazyweed was relocated and mapped. The Nuttal's pussy-toes survey covered 1487 acres divided into 155 survey zones. Of the zones surveyed 59 were found to contain populations of this species. This plant was found to be more abundant than first known.

Animals: Known sensitive species identified by the U.S. Fish and Wildlife Service or potentially present in LARO include four animals. One is known to occur in LARO, one species status is not known, and two are not known to occur in LARO. The known species is the bald eagle, listed as threatened in Washington by the U.S. Fish and Wildlife Service. The bull trout (*Salvelinus confluentus)*, a threatened species, is not known to exist in the reservoir, according to Spokane Indian Tribal Fisheries Biologists. Dr. Al Sholtz, Eastern Washington University, with extensive fishery experience on Lake Roosevelt, believes that lake conditions, such as temperature, are not suitable for bull trout. The last two, grizzly bear and gray wolf, have never been confirmed in LARO. Their presence, although unlikely, would be transitory in nature due to human activity and disturbance along the Recreation Area.

Resource Management Concerns

Land Use Impacts: Water is the major resource that makes up LARO. Lake Roosevelt is designated by the State of Washington as a class AA water body. This is the highest level in the state requiring the highest-level water quality standards. The water quality in Lake Roosevelt is somewhat impaired by both point and non-point pollutants. Studies have revealed that generally the water quality in solution is good but much of the sediment being carried in can tend to be toxic, containing heavy metals and organic pollutants.

The Columbia River above Lake Roosevelt has had close to 95 years of point pollution from a lead/zinc smelter (now one of the largest of its kind) located in Canada. Many tons of effluent and slag have flowed downstream into Lake Roosevelt. In the 1960's a pulp mill opened up upstream and began to discharge various congeners of dioxins and furans. This material has also appeared in the environment of Lake Roosevelt. The Spokane River has been an area of concern as well. The largest population centers in eastern Washington and the Panhandle of Idaho are upstream of Lake Roosevelt in the Spokane watershed. Upstream of these population centers is the Silver Valley Mining District that has operated for over 100 years.

The impacts of these sources of pollution are not as well defined. Current pollutants identified in the Spokane River portion of Lake Roosevelt have not been tied to any one known pollution source.

Exotic Plant Species: Some important "noxious weeds" include diffuse knapweed (*Centaurea maculosa*), spotted knapweed (*C. diffusa*), yellow star-thistle, leafy spurge (*Euphorbia esula*), Dalmatian toadflax, Canadian thistle, tumblemustard, and cheat grass. LARO staff conducts noxious weed control activities in cooperation with county weed control programs, adjacent landowners, and other affected parties on Lake Roosevelt. However, the invasion of noxious vegetation continues to be a serious problem because control efforts have been limited by insufficient funding. In addition the narrow linear nature of LARO and the numerous roads running the length of LARO provides numerous corridors of dispersal into and out of the area.

An inventory conducted in 2003 by the University of Idaho documented a total of 181 acres infested with weeds of the 1,233 acres surveyed. Several species were limited in distribution with a total of less than 2 acres infested and would be inexpensive to eliminate. Species with less than two acres include: bighead knapweed, Canada thistle, Italian thistle, houndstongue, Kochia and sulphur cinquefoil. Special attention should be paid to bighead knapweed, Italian thistle, houndstongue and sulphur cinquefoil. Other species had fewer than 30 acres and included spotted knapweed, diffuse knapweed, leafy spurge and rush skeletonweed. Dalmation toadflax was the most common species with 131 acres infested and probably a candidate for biological control (Prather 2003b).

UCBN park document(s) used in this park description:
Lake Roosevelt National Recreation Area Resource Management Plan, 1997.

MINIDOKA INTERNMENT NATIONAL MONUMENT (MIIN)

Size: 30 hectares (73 acres)

Designation Date: 2001

Park History and Purpose: Minidoka Internment National Monument was established in 2001 as the 385th unit of the National Park System to commemorate the hardships and sacrifices of Japanese Americans interned there during World War II. Also known as the 'Hunt Camp', the Minidoka Relocation Center was a 33,000-acre site with over 600 buildings and a total population of about 13,000 internees held from Washington, Oregon, and Alaska. It was in operation from August 1942 until October 1945.The purpose of the Minidoka Internment National Monument is to provide opportunities for public education and interpretation of the internment and incarceration of Nikkei (Japanese American citizens and legal resident aliens of Japanese ancestry) during World War II. The monument protects and manages resources related to the Minidoka Relocation Center.

Location: Located 17 miles Northeast of Twin Falls, Idaho and 21 miles East of Jerome, Idaho.

General Description: Features of significance are the cultural landscape and historical structures (currently listed assets are the grounds, entrance station and walls, potato cellar built by internees, and some foundations). Area has limited natural resources (approximately half the acreage is sage habitat with associated species). The area is surrounded by irrigation fields and developed farm area. No species of concern are known, although habitat might support burrowing owls, sage grouse (adjacent BLM area has leks) and bald eagles (using the canal). Vegetation and noxious weeds are the primary current resource management concern. A biological inventory is not planned for the Monument, however staff from Craters of the Moon NM and Hagerman Fossil Beds NM record all occurrences of vertebrates species observed when they are onsite. The species list is compiled by the UCBN I & M program.

Resource Management Concerns

Minidoka Internment National Monument does not have any visitor facilities or services available. The National Park Service began a three-year public planning process in the fall of 2002 to develop a General Management Plan (GMP) and Environmental Impact Statement (EIS). The General Management Plan will set forth the basic management philosophy for the Monument and will provide the strategies for addressing issues and achieving identified management objectives that will guide management of the site for the next 15-20 years.

Possible natural resource management objectives that have been proposed are to design natural resource management programs and activities to minimize conflicts with efforts to protect existing on-site cultural resources and landscapes, suppress all fires in order to protect natural and cultural features of the Monument, develop program to identify potential contaminants and environmental degradation resulting from historic uses, remove contaminants and remediate affected areas to eliminate continued degradation, manage vegetation to minimize or eliminate all undesirable exotic plant species, reestablish and manage vegetation to be consistent with patterns of vegetation present during the historic period, and utilize best management practices to prevent excessive run-off and soil erosion.

Website for additional information on the Monument and the planning process for development of the General Management Plan (http://www.nps.gov/miin/).

NEZ PERCE NATIONAL HISTORICAL PARK (NEPE)

Size: 858 hectares (2,122 acres)

Designation Date: 1965

Park History and Purpose: Nez Perce National Historical Park was established as a unit of the national park system on May 15, 1965, by Public Law 89-19. The law specifies the park was created to "facilitate protection and provide interpretation of sites in the Nez Perce Country of Idaho that have exceptional value in commemorating the history of the Nation." Specifically mentioned are sites relating to early Nez Perce culture, the Lewis and Clark expedition through the area, the fur trade, missionaries, gold mining, logging, the Nez Perce War of 1877, and "such other sites as will depict the role of the Nez Perce country in the westward expansion of the Nation." Sites include historic buildings, battlefields, missions, landscapes, cemeteries, trails, archeological sites, and geologic formations important to the Nez Perce people. A total of 24 sites were established in 1965.

Public Law 102-576 of October 30, 1992, allowed sites to be designated in Oregon, Washington, Montana, and Wyoming. It specified that 14 additional sites in Idaho, Oregon, Washington, and Montana should be included in the park.

Today, the 38 sites of the Nez Perce National Historical Park, scattered across the states of Idaho, Oregon, Washington and Montana, have been designated to commemorate the legends and history of the Nee-Me-Poo (or Nez Perce) and their interaction with explorers, fur traders, missionaries, soldiers, settlers, gold miners, and farmers who moved through or into the area.

On the basis of provisions in the enabling legislation, the purpose of Nez Perce National Historical Park is to:

- Facilitate protection and offer interpretation of Nez Perce sites in Idaho, Oregon, Washington, Montana, and Wyoming that have exceptional value in commemorating the history of the United States.
- Preserve and protect tangible resources that document the history of the Nez Perce peoples and the significant role of the Nez Perce in North American history.
- Interpret the culture and history of the Nez Perce peoples and promote documentation to enhance that interpretation.

Location: Park Headquarters and Visitor Center are located in Spalding, Idaho, 11 miles east of Lewiston. An additional Visitor Center is located at Big Hole National Battlefield, 10 miles west of Wisdom, Montana. Interpretive shelters at Heart of the Monster (Kamiah) and White Bird Battlefield tell the story of events at each location. The shelter at White Bird presents a panoramic view of the battlefield. From this point you can get an idea of how the battle occurred and how skillfully the Nez Perce used the terrain to defeat the U.S. Army. A self-guided (primitive) hiking trail is accessible via old U.S. 95 north of White Bird. At Kamiah the exhibits explain the Heart of the Monster -- the Place of Beginning where the Nez Perce people sprang from the drops of blood squeezed from the monster's heart. An audio station recounts the legend. Self-guiding trails are present at the Big Hole and Bear Paw Battlefield sites, as well as a self-guided walking tour of the Spalding site.

Elevation: Varies widely between sites.

General Description: The areas encompassing the 38 sites that comprise Nez Perce National Historical Park display the great diversity of the American West -- topography, rainfall, vegetation, and scenery, ranging from the semi-arid regions of Washington, to the lush high mountain meadows of Idaho and Oregon, to the prairies of Montana. The natural resources of Nez Perce NHP are diverse and complex. Scattered throughout four states, the park sites are mostly small pockets of land owned and surrounded by a patchwork of private, local, state, tribal, and other federal ownership.

Because Nez Perce National Historical Park is so widespread geographically, the parkwide environment is difficult to describe. Nez Perce National Historical Park falls into three basic ecoregions: the *shortgrass prairies* of the Palouse Grasslands and Missouri Basin, the *sagebrush steppe* of the Columbia and Snake River Plateaus, and the *conifer/alpine meadows* of the Blue

Mountains, the Salmon River Mountains, the basins and ranges of south-western Montana, and the northern Rocky Mountains of Idaho and Montana.

Fauna/Flora: Three major habitats characterize the diversity of NEPE sites, Shortgrass prairie, sagebrush steppe and conifer/alpine meadow.

Shortgrass prairies

Shortgrass prairies are characterized by flat or rolling expanses of low to moderate relief. The elevations of shortgrass prairies in the park range from less than 1,000 feet to about 3,500 feet These prairies are dissected by rivers and streams forming canyons and valleys. Because these regions are relatively dry, they are dominated by shortgrass species such as wheatgrass, fescue, and bluegrass in the Palouse area and buffalo, gramma, wheatgrass, and needle-grass in the Missouri Basin. Wildflower species bloom in spring and summer. The Nez Perce used many of these such as the camas lily as a source of food, medicine, and fiber.

The Palouse supports an abundance of wildlife. Bald eagles are frequent visitors to the reaches of the Columbia, Snake, and Clearwater Rivers. Osprey, red-tailed hawk, and other raptors are common, as are a wide variety of migratory and resident birdlife. Cottontail rabbits, ground squirrels, coyotes, bobcats, and skunks also abound in these grasslands.

The Missouri Basin was once the home of large herds of bison. Pronghorn antelope are now the most common large mammal, but deer may be found along stream channels where brush cover is available. Whitetail jackrabbits, desert cottontail, ground squirrels, coyotes, and badgers are common. Hawks are abundant, along with smaller birds such as the lark bunting, the horned lark, and the meadowlark. Rattlesnakes are also fairly common.

The Missouri Basin sites of shortgrass prairie are the Bear Paw Battlefield and Canyon Creek.

The following sites are in the Palouse Grasslands of the shortgrass prairie ecoregion: Ant and Yellowjacket, Asa Smith Mission, Camas Prairie, Canoe Camp, Clearwater Battlefield, Confluence Overlook, Cottonwood Skirmishes, Coyote's Fishnet, Craig Donation Land Claim, Fort Lapwai, Hasotino Village Site, Heart of the Monster, Lapwai Mission, Lenore, Lewis and Clark Long Camp, Looking Glass Camp, McBeth Mission, Musselshell Meadow, Pierce Courthouse, Saint Joseph's Mission, Spalding, Tolo Lake, Weippe Prairie, Weis Rockshelter, White Bird Battlefield.

Sagebrush steppe

Sagebrush steppe is characterized by the plains and tablelands of the Columbia and Snake River Plateaus. These mid-elevation (3,000 feet) plateaus include most of the Northwest's lava fields and are surrounded by lava flows that have been folded or faulted into ridges.
The climate on these plateaus is again semiarid and cool. The average annual precipitation is about 16 inches, with precipitation distributed fairly evenly from fall to spring. The predominant vegetation is a variation of sagebrush, shadscale, and short grasses. Stream channels may support a lush understory of willow and other riparian obligates but will rapidly graduate to more arid, alkali-tolerant species such as greasewood, particularly farther from the mountains.

Many wildlife species use these areas as seasonal habitat, particularly during winter. Larger mammals found in these areas are coyote, pronghorn antelope, mountain lion, and bobcat. Smaller species include ground squirrels, deer mouse, and porcupine. Severe winters may force elk and mule deer from higher elevations to these plateaus. The geography of this area supports habitat that is important for many species of migratory waterfowl. Park sites of the sagebrush steppe are Camas Meadows, Dug Bar, Buffalo Eddy, Nez Perce Cemetery, and Nez Perce Campsites.

Conifer/Alpine Meadows

The Idaho Batholith, which forms the Bitterroot Range over which the Lolo Trail crosses, and the Wallowa and Blue Mountains in eastern Oregon, are marked with distinctive elevation zones of vegetation. In the Idaho Batholith and the Blue Mountains, Douglas-fir is the climax dominant conifer below the subalpine zone. The Bitterroot Range is dominated by a subalpine belt of mountain hemlock. Below this, western redcedar and western hemlock dominate, but Douglas-fir, western white pine, western larch, and western ponderosa pine can be found in association. Lodgepole pine and grasses are dominant in the basin-and-range areas. Ponderosa pine is scattered below these areas and dominates west of the Continental Divide. The lower mountain slopes of all these areas may graduate from conifer to sagebrush and grass steppe lands.

Some of the larger mammals in these areas are elk, deer, moose, black bear, mountain lion, bobcat, beaver, and porcupine. Blue and ruffed grouse are common game birds. Severe winters in the higher elevations are usual in these areas. Winter temperatures frequently drop below 32°F, and summer highs may reach only 70°F. Temperature and snowfall vary greatly with elevation. Precipitation varies from 20 to 40 inches per year and comes predominantly in snowfall during the winter months.

Park sites that are in the conifer/alpine meadows ecoregion are Lolo Trail and Pass, Lostine Campsite, Old Chief Joseph Gravesite, Joseph Canyon Viewpoint, and Big Hole National Battlefield.

Animals that have been observed to consistently occupy Nez Perce NHP sites in Idaho include white-tailed deer, great horned owls, redtail hawks, coyotes, game birds, and various rodents such as beaver, mice, voles, and gophers. Skunks, raccoons, porcupines, and birds common to the northern Idaho ecosystem are also found within the park boundaries. Migratory mammals such as deer, elk, and moose, as well as a large variety of birds and raptors, including bald and golden eagles, have been commonly seen at the Idaho sites.

Mammals: Thirty-four species of non-volant mammals were documented at 5 NEPE sites in 2002 (Strobel et al. 2003b). The mammals with the highest occurrence across all five sampling sites were the coyote, the deer mouse, the mule deer, the white-tailed deer, and the northern pocket gopher.

Birds: In 1999, in conjunction with the Servicewide Inventory and Monitoring Initiative, an intensive inventory for avian species was initiated at all park managed sites and on the Lolo Trail. This inventory of avian wildlife detected 69 bird species at Buffalo Eddy, 69 bird species at Spalding, 64 bird species at Heart of the Monster, 66 bird species at Lolo Trail and Lolo Pass /

Musselshell Meadow, 84 bird species at White Bird Battlefield, 59 bird species at Old Chief Joseph Gravesite, and 53 bird species at Bear Paw Battlefield (Dixon 2004).

Migratory waterfowl, including large numbers of Canada geese, frequently use the park sites along the Clearwater River in Idaho. The geese nest on river islands immediately adjacent to at least two of the park sites. The Spalding site is adjacent to the Lewiston Wildlife Refuge, managed by the Idaho Department of Fish and Game.

Herptofauna: A total of 11 species of amphibians and reptiles were confirmed in 2002 (Strobel et al. 2003b). The western toad was the most widely distributed amphibian with the highest estimated abundance across all sites sampled. The bullfrog had the second highest abundance, occurring at two locations. The racer was the most widely distributed reptile with the highest abundance across all sites sampled. The western terrestrial garter snake had the second highest abundance within all sites sampled.

Fish: The park needs to obtain results of systematic inventories of fish from the Nez Perce tribe.

Aquatic Features: The Clearwater River, adjacent to several park sites, is a major recreational resource and contains federally listed salmon and steelhead. Fishermen from the United States, Canada, and other places in the world, enjoy this year-round trophy fishery. The river also provides opportunities for boating, other river-associated recreation, and limited hunting. The park sites along the river provide walk-in access for some of these types of recreation.

Unique Features and Species of Special Concern

No inventory has been conducted in the park to determine the presence of endangered, threatened, or rare species. Some have been seen on park lands and waters, such as bald eagles on the Clearwater River and Montana arctic grayling in the North Fork of the Big Hole River.

Federally listed threatened or endangered species that could occur in the park are gray wolf, peregrine falcon, bald eagle, Snake River sockeye salmon, chinook salmon, and MacFarlane's four o'clock (*Mirabilis macfarlanei*). Additional species that are state-listed threatened or endangered species or federal candidate species that could occur in the park are California wolverine, swift fox (*Vulpes velox*), great gray owl (*Strix nebulosa*), boreal owl, mountain plover (*Charadrius montanus*), westslope cutthroat trout, bull trout, fluvial arctic grayling, pygmy gentian, white-margined knotweed, Lemhi beardtongue (*Penstemon lemhiensis*), stalk-leaved monkeyflower (*Mimulus patulus*), and candystick (*Andromeda polifolia*).

Resource Management Concerns

Most of Nez Perce National Historical Park's natural resource issues have involved vegetation management. Early efforts focused on maintaining a "park-like quality" and prohibiting land uses that would detract from each site's historical appearance. Gradually the park administration adopted a variety of management tools and assumed the more ambitious goal of restoring the vegetation to its historic appearance. These tools included noxious weed control, prescribed burning, reseeding of native grasses, and selective use of grazing and farming.

Restoration of Historic Vegetation: Native vegetation for the riparian areas of the Spalding, East Kamiah, and Canoe Camp sites may have once included dogwood, ponderosa pine, hawthorn, sedges, tufted hairgrass, cottonwood, snowberry, willows, chokecherry, elderberry, serviceberry, and grasses such as canary grass and bunchgrasses. The intermountain grassland, best represented by White Bird Battlefield, were perhaps dominated by Idaho fescue, bluebunch wheatgrass, and rabbitbrush. Perennial forbs included roundleaf alumroot, arrowleaf balsamroot, and Wyeth eriogonum. The landscape at many of the sites is now impacted, if not dominated, by exotics such as cheatgrass, various thistles, yellow starthistle, poison hemlock, moth mullein, field bindweed, and teasel.

The natural resources of the park have been greatly impacted by a long history of human use. Native grass and floral communities have been damaged or displaced by the effects of grazing, agriculture, and mechanical disturbances. At Big Hole, the exclusion of the natural fire regime appears to have altered forest succession. The absence of perennial forbs in the prairie is another consequence of disturbance: Though native trees and shrubs still exist, exotic annual grasses have replaced many of the native perennials and often outcompete seedlings of native species.

Little if any of the original native plant communities remain at Spalding. A long history of disturbance--including intensive grazing, agricultural use, road building and maintenance, off-road vehicle disturbances, and landscaping around historic homesites--has left large areas susceptible to invasions by annual grasses and other exotic or noxious weeds.

Exotic Plant Species: The spread of exotic and noxious weeds continues to be the major natural resource issue at all park sites. In the past, local weed control districts have made requests of the park to control its infestations of yellow starthistle and Scotch thistle, field bindweed, poison hemlock, and other weed species. Species such as yellow starthistle, scotch thistle, field bindweed, poison hemlock, and others are rapidly outcompeting existing vegetation. On-going control efforts are primarily limited to mechanical (and some herbicide) treatments at Spalding, East Kamiah, and Big Hole.

Grazing: Grazing on park sites was curtailed in 1997 with the exception of the new unit, Weippe Prairie. Although the impacts of current and past grazing practices on the park sites are not thoroughly understood, it probably has contributed to the overall decline of natural vegetative productivity and provided an opportunity for the encroachment of annual grasses and other exotics.

Water Quality: High water quality and quantity are major resources of many park sites. The Clearwater and Snake Rivers and their tributaries (which are adjacent to several park sites) are critical habitat for several species of anadromous fish.

Air Quality: The park is designated as a Class II site for air quality. Most of the park sites are in rural areas with few sources of air quality degradation. However, lumber and paper mill activity near the Spalding and Heart of the Monster sites have negatively affected the quality of air and visual resources nearby.

UCBN park document(s) used in this park description:
Nez Perce National Historical Park Resource Management Plan,

WHITMAN MISSION NATIONAL HISTORIC SITE (WHMI)

Size: 40 hectares (98 acres)

Designation: 1936

Park History and Purpose: Whitman Mission National Historic Site was established in 1936 to preserve the site of a mission founded in 1836 by Marcus and Narcissa Whitman among the Cayuse people of the Inland Pacific Northwest. The site was the first American settlement in the Pacific Northwest and became an important way station along the Oregon Trail.

Location: Whitman Mission National Historic Site is located at the southern extreme of the Palouse Prairie region of southeastern Washington in Walla Walla, WA. The township and range reference is Township 7 North, Range 35 East, Section 32, of the USGS (United States Geologic Survey) Topographic Quadrangle Map, College Place 1966.

From I-84, travel north on Oregon Route 11 from Pendleton, Oregon to Walla Walla, Washington, then on U.S. Route 12 go west 7 miles.

Elevation: General elevation within Whitman Mission National Historic Site is level and ranges from 615 feet above sea level to 724 feet at the top of Memorial Hill (which rises over 100 feet above the surrounding countryside).

Climate: Whitman Mission National Historic Site is surrounded by a dry, moderate climate. Annual precipitation in the vicinity of the NHS averages 19.48 with approximately 17.8 inches of snow during the winter months. The daily temperature variation can be as much as 40 degrees during the summer. Mean monthly maximum temperature ranges from 40.1 to 97.3 degrees Fahrenheit, while mean minimum temperature ranges from 26.6 to 57.4 degrees Fahrenheit. Frequent, strong winds can occur anytime, as well as Chinook winds. Prevailing winds year around come from the southwest.

Resource Management: Resource management at this site is dedicated to preserving the archeological, historical and landscape values associated with the Whitmans during their work from 1836 to 1847. These include native vegetation and landscape features the Whitmans would have seen and used during their lives at the mission.

The first objective listed in the general management plan for WHMI is to protect and preserve the cultural and natural resources of Whitman Mission. Strategies to achieve this objective include: 1) Inventory cultural and natural resources, 2) Manage, update, and maintain the park's resource information database (includes GIS), 3) Manage and protect park collections and archives, 4) Manage and protect park structural landscape component, including monuments, graves, and landscape features, 5) Implement and sustain a cultural and natural resource-monitoring program, and 6) Use IPM/fire to protect park resources.

The second objective listed in the general management plan for the park is to restore and preserve the park's natural resources, including riparian and wetland areas, and the cultural landscape. Strategies listed to achieve this objective include: 1) Identify options for Doan Creek and irrigation ditch management and implement the selected option, 2) Manage vegetation, and 3) Collaborate with other federal and state agencies in the protection of hydrologic and aquatic resources.

Flora: The staff at Whitman Mission National Historic Site has compiled a vascular plant checklist and a collection of voucher specimens. There are 190 specimens in the herbarium. At this time, there are no known federally listed threatened or endangered plant species within the NHS.

Whitman Mission is located on the southern extreme of the Palouse Prairie Region. Originally, perennial grasses, principally bluebunch wheatgrass which flourished in swords over the rolling plains, dominated this prairie. Intermixed with it were smaller patches of sandberg bluegrass and Idaho fescue. The region is classified as the *Agropyron-Poa* habitat type. Large native herbivores were generally absent from the Palouse, and because of this, the grasses evolved with a low resistance to grazing. Subsequent grazing by domestic livestock and extensive cultivation for wheat are the main reasons why native perennial grasslands are now rare on the Palouse.

The original inhabitants of the area around Whitman Mission were the Cayuse Indians. The Cayuse practiced very little crop agriculture, depending instead on a partially nomadic existence that emphasized food gathering, horse raising, and salmon fisheries. Fire was used periodically by the Cayuse to burn particular areas to increase the production of wild forage and accessibility of plant foods, to facilitate hunting and travel by burning away underbrush, and to encircle game. The regularity with which the areas on or near, the historic site were burned historically cannot be determined, but frequent cultural burning of any particular area was probably rare.

It is probable that at the time the mission was established, a mixture of three plant communities occupied the site. At the time the mission was established in 1836, the Walla Walla River flowed through the site during times of high water. On the floodplains along the Walla Walla River and nearby Mill Creek, a narrow plant community consisting of dense tangled thickets of willows, cottonwoods, red-osier dogwood (*Cornus stolonifera*), blackberries (*Rubus* spp.), elderberries (*Sambucus* spp.), and other species common to riparian areas probably occurred. An association of perennial grasses, shrubs, and native forbs occupied the hillside area where soil depths and drainage were greater. Perennial grasses common to the Palouse dominated the rest of Whitman Mission.

Intermixed throughout the site was giant wild ryegrass, a species preferring a year-round supply of soil moisture and occurring primarily on clay bottomlands and seepage areas. It now occurs as scattered large bunches of grass, but historically, it may have been more extensive. It was this species that gave the Indian name to the location, *Waiilatpu*, meaning, place of the people of the rye grass.

It is likely that the Cayuse used the resources at the site at least periodically for centuries before the mission was established. Archeological evidence of modification to the natural conditions has not been documented. However, soon after the mission was established, an irrigation system was developed, crops were planted, and areas were opened to grazing by draft stock and cattle. A considerable number of stock animals moved through the mission from the Oregon Trail, and there was ample opportunity for the introduction of exotic plants. The changes that occurred to the plants and landscape during the time the mission was active -- the introduction of domestic livestock, exotic plants and agriculture, and the removal of riparian vegetation for fire and building wood, were a portent of things to come for the entire Palouse Prairie.

<u>Fauna:</u> The bald eagle is the only federally listed threatened or endangered wildlife species that has been observed within the NHS boundaries. There are no proposed or candidate species identified within the area of the NHS.

<u>Mammals:</u> Wildlife at Whitman Mission National Historic Site is represented primarily by a variety of small rodents. Twenty-seven mammal species were confirmed during a 2003 inventory (Rodhouse et al. 2003). The most common mammals are cottontail rabbits (*Sylvilagus* spp.) voles (*Microtus* spp.) deer mice, western harvest mice and northern pocket gophers. Also present are beaver, whitetail deer, mule deer, muskrats, raccoons, weasels, skunks, badgers, porcupines, and feral house cats (*Felis catus*).

<u>Birds:</u> A variety of common birds, ducks, and geese have been seen within Whitman Mission National Historic Site. One hundred seventeen birds were expected to occur in or adjacent to the mission and 202 species were confirmed, including all 117 expected species (Rodhouse et al. 2003)

Bird species commonly observed include mourning dove (*Sandier macroura*), woodpeckers (*Picoides* spp and *Mealnerpes* spp), barn owls, swallows (*Hirundo* spp.), wrens, (*Troglodytes aedon*), Wilson's warblers (*Wilsonia pusilla*), yellow-rumped *warblers (Dendroica coronate auduboni*), sparrows (*Spizella* spp., *Melospiza* spp., and *Zonotrichia* spp.), robins (*Turdus migratorius*), juncos (*Junco* spp.) starlings, crows (*Corvus* spp.), hawks (*Accipeter* spp. and *Buteo* spp.), pheasants, mallards (*Anas platyrhynchos)* and Canada geese. Other species seen are California quail, bobwhite quail (*Colinus virginianus*) and wild turkey.

Bald eagles, a federally listed species, occasionally pass through the NHS. There are no known nesting sites within or in close proximity to the NHS.

<u>Amphibians and Reptiles:</u> A total of 3 amphibians and 5 reptiles were documented on the mission during 2002 (Rodhouse et al. 2003). Bullfrogs are abundant around the Millpond, Mill Creek, and along the irrigation channel. Common garter snakes and gopher snakes have been observed at various locations throughout Whitman Mission National Historic Site. Painted turtles are found here as well. The 2002-2003 inventory confirmed the great basin spadefoot toad, a unique species of amphibian.

<u>Fish:</u> The following species of fish are found in Mill Creek: steelhead (*Oncorhynchus mykiss*), carp, and sunfish (*Eupomotis gibbosus*) No other information is available concerning fish in the

waters running through the NHS. However, occasionally fish (carp) do enter the irrigation channel.

Water Resources: Surface water resources at the National Historic Site include Mill Creek, Doan Creek, the Millpond, and the irrigation ditch. Mill Creek originates in the Blue Mountains, approximately 30 miles east of Whitman Mission and flows through the northwestern corner of the NHS. Doan Creek originates three miles east of the NHS and passes through a private airport, a former dairy, and agricultural land before entering the NHS at the northeastern boundary. Here, Doan Creek splits into two channels through the NHS; one continuing west along the northern boundary until joining with Mill Creek (this is the channel referred to as Doan Creek); and the other channel turning south, then west and connecting back to Mill Creek just west of Sweagle Road near the intersection with Whitman Mission Road (the NHS's entrance road). Doan and Mill Creeks come together at the northwestern boundary of the NHS. Further west, Mill Creek joins the Walla Walla River.

The historic Millpond covers about two and one-half acres and is held by earthen dikes. The Millpond was restored in 1961, and is located on the eastern end of the mission grounds. The irrigation channel from Doan Creek supplies the Millpond.

Marcus Whitman is credited with establishing the first irrigation ditch in this area. In one form or another at least one irrigation ditch has crossed the mission grounds since Whitman's time. Currently, Whitman Mission National Historic Site is responsible for maintaining 5,967 feet of irrigation ditch in accordance with Washington State law. The current irrigation ditch on the NHS land supports water that supplies two farms west of the NHS.
In addition to the existing surface water resources, evidence exists of former stream channels for both Doan Creek and the Walla Walla River. A former Doan Creek channel is an important wetland habitat in the northeastern quarter of the NHS. The former channel of the Walla Walla River (the oxbow of the Walla Walla River) is important to the interpretation of the history of Whitman Mission National Historic Site.

Resource Management Concerns

Exotic Plants: Whitman Mission contains non-native plants that occur in all areas of the park. By 1985, major emphasis for maintenance within the NHS was being placed on revegetation and the control of exotic plant species. Vegetation management has converted 60% of the NHS from exotic grasses and weeds to grasses that grew in the area during Whitman's era, or to grasses that have the same appearance as the native grasses. These native-appearing grasses will gradually be replaced with native species by NHS staff.

In 1994, a vegetation plan was developed and implemented for the area surrounding the visitor center. In 1995, vegetative alternatives were developed for treating exotics on the banks of the irrigation channel. Some implementation has been initiated.

In 1997, an inventory of exotic pest plant species identified the following six species of concern: field bindweed, jointed goatgrass (*Aegilops cylindrica*), poison hemlock, yellow starthistle, Canada thistle, and Scotch thistle. Control strategies for these species have been developed, and incorporate more extensive use of integrated pest management techniques.

Wetlands: Approximately ten acres of the NHS is wetland, but is not formally classified as such in any NPS, U.S. Army Corps of Engineers, National Wetlands Inventory, or Natural Resource Conservation Service document. While there are no springs within the NHS, there are distinct former stream channels of Doan Creek and the Walla Walla River, which hold water in the winter and spring. There is a wetland enhancement project planned by NHS staff to unchannel Doan Creek along the northern boundary to allow more water to meander, creating more wetland habitat. The U.S. Army Corps of Engineers has purchased land that borders the south boundary of the NHS and the north bank of the Walla Walla River. The State Department of Fish and Wildlife is administering land along this southern boundary as a riparian habitat. Management of this land in its natural state is compatible with the historic setting of the NHS.

UCBN park document(s) used in this park description:
Whitman Mission National Historic Park Resource Management Plan,

Appendix B-2. Areas within 10 miles of National Park Service units in the Upper Columbia Basin Network that are managed for the long-term maintenance of biodiversity.

Little information is available on the flora, fauna, and habitat connectivity of these areas. Therefore it is difficult to determine the degree to which these areas contribute to maintaining the ecological integrity of park surroundings.

Park	Nearby Conservation Area[1]	Managing Agency[2]	Distance (Mi)
Hagerman Fossil Beds NM	Thousand Springs Ranch and Preserve	TNC	< 5
	Hagerman Wildlife Management Area	IDFG	< 5
	Box Canyon / Blueheart Springs ACEC	BLM	< 10
Minidoka Internment NM	Vineyard Creek ACEC	BLM	< 10
City of Rocks NR	Jim Sage Canyon Research Natural Area	BLM	< 10
Craters of the Moon NM and Preserve	Bear Track Williams Recreation Area	IDFG	< 5
	Preacher Bridge Access Area	IDFG	< 5
	Carey Lake Wildlife Management Area	IDFG	< 5
	Minidoka National Wildlife Refuge	USFWS	< 5
	Silver Creek Access Area	IDFG	< 10
	Silver Creek Easements	TNC	< 10
	China Cup Butte Research Natural Area	BLM	< 10
	Idaho National Engineering and Environment Laboratory	DOE	< 10
Nez Perce NHP (Idaho portion)	Lower Salmon River ACEC	BLM	< 5
	Hells Canyon National Recreation Area	USFS	< 10
	Lower Lolo Creek ACEC	BLM	< 10
	Middle Fork Clearwater Wild River	USFS	< 10
	Craig Mountain Wildlife Management Area	IDFG	< 5
	Redbird Creek Research Natural Area	BLM	< 5
	Captain John Creek Research Natural Area / ACEC	BLM	< 5
	Craig Mountain ACEC	BLM	< 5
	Garden Creek Preserve	TNC	< 10
	Chief Joseph Wildlife Recreation Area	WDFW	< 10
Nez Perce NHP (Oregon portion)	Eagle Cap Wilderness Area	USFS	< 5
	Hells Canyon National Recreation Area	USFS	< 5
Lake Roosevelt NRA	Northup Canyon State Park	WA STATE	< 5
	Sherman Creek Wildlife Area	WA STATE	< 5
John Day Fossil Beds NM	Spring Basin Wilderness Study Area	BLM	< 5
	Pine Creek Conservation Area	CTWS	< 5
	Bridge Creek Wilderness Area	USFS	< 10
	Aldrich Mountain Wilderness Study Area	BLM	< 10
	Murderer's Creek Wildlife Area	ODFW	< 10
	Black Canyon Wilderness Area	USFS	< 10

[1] ACEC = Area of Critical Environmental Concern
[2] Managing agencies include The Nature Conservancy (TNC), Idaho Department of Fish and Game (IDFG), Bureau of Land Management (BLM), US Fish and Wildlife Service (USFWS), Confederated Tribes of Warm Springs (CTWS), Department of Energy (DOE), US Forest Service (USFS), Washington Department of Fish and Wildlife (WDFW), Washington state (WA STATE), and Oregon Department of Fish and Wildlife (ODFW).

Appendix B-3. Soil descriptions of the Upper Columbia Basin Network (Quigley and Arbelbide 1997).

LARO

Province M333 Northern Rocky Mountain Forest-Steppe-Coniferous Forest-Alpine Meadow—Province M333 occurs in northeastern Washington, northern Idaho, and northwestern Montana. It is mountainous with elevations that range from approximately 370 to 3,000 meters. This area has a maritime-like climate, except in the east where a continental climate prevails. The average annual precipitation varies from about 400 to 2,500 millimeters. The dominant vegetation types are cedar hemlock pine, western white pine, and Douglas-fir forests. Volcanic ash covers most of the area. Soil productivity of Province M333 is generally good because of the volcanic ash soils (Geist and Cochran 1991) and the presence of favorable temperatures and precipitation (maritime climate and low-to-moderate elevations). The most productive areas are the low- to mid-elevation sites where neither temperature nor moisture are considered limiting. The least productive soils occur west of the Columbia River and are shallow and stony, and lack volcanic ash. Northern Rocky Mountain forests have generally low susceptibility to surface fuel accumulations because of their long fire cycles and relatively high productivity. Fuel accumulations remain close to historical norms. These systems are also more capable of replacing soil organic matter, coarse woody debris (larger than 10 cm in diameter), and nitrogen losses than lower productivity systems. In most cases, these forests can be considered moderately buffered against soil damage and in relatively good condition. However, where western white pine mortality from blister rust has been high and large amounts of dead material have accumulated, these fuels can represent a substantial risk for causing soil damage if the site were to burn when fuels are dry.

BIHO, NEPE

Province M332 Middle Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow Province—Province M332 occurs in central Idaho, westcentral and southwestern Montana, and northeastern Oregon. Elevations generally range from approximately 300 to 3,700 meters. This province includes mountains with narrow valleys, basins, alpine meadows, and breaklands. Most of the higher elevations have been glaciated. Maritime climate, westerly winds, and orographic precipitation yields less than 500 millimeters at the lowest elevations to over 750 millimeters in mountainous areas. Vegetation is dominated by Douglas-fir, ponderosa pine, grand fir, sagebrush steppe, and fescue/wheatgrass grassland. The soils of Province M332 are only moderately productive because of their shallow depths associated with mountain locations, cold temperatures, and low precipitation in some areas. The most productive soils occur in valleys and basins where they are often deep, have high volcanic ash content, and receive higher precipitation. Heavy fuel accumulations and dense stand conditions in some areas place long- and short-term soil productivity potential at risk from wildfire. In contrast, where high fuel and/or dense stand conditions are absent, the risk of potential damage to soils from wildfire is minimal. Where heavy fuels exist (especially on the most sensitive soils), future soil conditions are likely to degrade when wildfires do occur.

CIRO, CRMO, HAFO, MIIN, NEPE, JODA, WHMI

Province 342 Intermountain Semi-Desert—Province 342 consists of plains, tablelands, and plateaus in central Washington, southcentral andsoutheastern Oregon, and southern Idaho. Elevations range from approximately 60 to 2,400 meters. This area has a semi-arid, cool climate. Average annual precipitation varies from about 100 to 625 millimeters. Dominant vegetation types are sagebrush steppe and grassland. Low productivity soils are common in Province 342 because of the sparse precipitation and low soil organic matter levels that occur throughout much of the province. Even though moisture is the most limiting factor for these soils, organic matter and nitrogen values are also generally limiting. Organic matter amounts vary with moisture throughout the province. Riparian/wetland areas and high elevation forested and grass/shrub sites have the highest organic matter; the young lava flows, sand dunes, and saline-sodic soils have the least organic matter. In addition, extensive fires in some parts of the province have reduced organic matter and nitrogen contents to critical levels. This situation has often resulted in the expansion of cheatgrass monocultures, which are susceptible to repeated burn cycles that further degrade soil productivity. Although most forests in this area produce low amounts of fuels, high fuel accumulations that contribute to hot fires can occur on more productive sites.

Appendix B-4. Geoclimatic characteristics of the Upper Columbia Basin Network compiled by the ICBEMP for ecological reporting units (Quigley and Arbelbide 1997).

ERU	Landforms	Bedrock and Surficial Material	Elevation Range (m)	Mean Annual Precipitation and Temperature	Major Potential Vegetation Groups
Columbia Plateau (NEPE, WHMI, JODA)	Plateaus, hills, and plains	Basalts and volcanic rocks; loess, glacial outwash, and flood deposits	61-1,220	180-450 mm 4 to 14^{0}C	Sagrebrush, Bluebunch wheatgrass, and Idaho fescue
Northern Glaciated Mtns. (LARO)	Glaciated mountains, foothills, basins, and valleys	Granitic, gneiss, schist, siltite, shale, quartzite, carbonate; glacial till, and outwash	244-3,081	410 to 2,540 mm -1 to 14^{0}C	Douglas-fir, ponderosa pine, grand fir, western hemlock, and subalpine fir.
Owyhee Uplands (HAFO, MIIN)	Dissected mountains, plains, plateaus, and foothills	Volcanic basaltic flows and pyroclastic rocks	641-2,501	200 to 400 mm 2 to 8^0 C	Salt desert shrub, sagebrush, and juniper
Upper Snake (CIRO, CRMO)	Basins, valleys, mountains, plateaus and plains.	Volcanic-basalt to rhyolite: and carbonate, phosphate, clastic sedimentary rocks	397-2,288	100 to 790mm 4 to 13^0 C	Salt desert brush, sagebrush and juniper
Central Idaho Mountains (NEPE)	Dissected mountains, breaklands, canyons, basins, foothills, and valleys, and some alpine glaciation	Granitics, gneiss, schist, shale, carbonate rocks, and volcanic rocks	427-3,861	250 to 2,030mm 3 to 10^0 C	Douglas-fir, grand fir, sagebrush, grasslands, and subalpine fir
Blue Mountains (JODA, NEPE)	Low to moderate relief plains, foothills and mountains with narrow valleys and breaks	Paleozoic and Cenozoic sediments, Cenozoic basalts	762-3,048	250-1270 mm 3 to 14^0 C	Douglas-fir, grand fir, sagebrush, grasslands, and subalpine fir

Appendix B-5. Description of geologic sections of the Columbia Plateau within Upper Columbia Basin parks (Quigley and Arbelbide 1997).

Columbia Plateau

The Columbia Plateau is the most significant geologic province of the UCBN and its unique volcanic geology dominates much of the present day landscape in the UCBN. The plateau contains one of the world's largest accumulations of lava. The topography here is dominated by geologically young lava flows that inundated the countryside with amazing speed, all within the last 17 million years. Over 170,000 cubic kilometers of basaltic lava, known as the Columbia River basalts, covers the western part of the province. These tremendous flows erupted between 17 and 6 million years ago. Most of the lava flooded out in the first 1.5 million years—an extraordinarily short time for such an outpouring of molten rock. Over 300 high-volume individual lava flows have been identified, along with countless smaller flows. Numerous linear vents, some over 150 kilometers long, show where lava erupted near the eastern edge of the Columbia River Basalts, but older vents were probably buried by younger flows. Similar flood basalts occurred further east in the Snake River Plain. Following this period of intense volcanism were the repeat events of glaciation during the Pleistocene Epoch that reshaped much of the Columbia Plateau. Continental ice sheets reached as far south as the Spokane area in eastern Washington, and montane glaciers reached farther south down the Rocky Mountain and Cascade chains. Massive pluvial lakes and ice dams drove repeated flood events that continue to have a tremendous effect on modern day geomorphology as well as land use practices.

Snake River Plain – City of Rocks NR, Craters of the Moon NM, Hagerman Fossil Beds NM and Minidoka Internment NM

The Snake River Plain stretches across southern Idaho, includes portions of eastern Oregon and northern Nevada, and ends at the Yellowstone Plateau in Wyoming. Looking like a great spoon scooped out of the Earth's surface, the smooth topography of this province forms a striking contrast with the strong mountainous fabric around it. The Snake River Plain lies in a distinct depression. At the western end, the base has dropped down along normal faults, forming a graben structure. Although there is extensive faulting at the eastern end, the structure is not as clear there.

Like the Columbia River region to the west, volcanic eruptions dominate the story of the Snake River Plain in the eastern part of the Columbia Plateau province. The earliest Snake River Plain eruptions began about 15 million years ago, just as the tremendous early eruptions of Columbia River Basalt were ending. Most of the Snake River Plain volcanic rock is of Pliocene age (5-1.6 million years ago) and younger.

In the west, the Columbia River Basalts are almost exclusively made of black basalt. In the Snake River Plain relatively quiet eruptions of soupy black basalt lava flows alternated with tremendous explosive eruptions of rhyolite, a light-colored volcanic rock.

Cinder cones dot the landscape of the Snake River Plain. Some are aligned along vents and fissures that fed flows and cone-building eruptions. Calderas, great pits formed by explosive volcanism, low shield volcanoes, and rhyolite hills are also part of the landscape, but many are obscured by later lava flows.

Craters of the Moon lava field lies along the northern border of the Snake River Plain, midway between Arco and Carey, Idaho. It consists of Holocene to Pleistocene lava flows, cinder cones, spatter cones, lava tubes, and other features typical of basaltic volcanism. Much of the field lies within CRMO and over 80% of CRMO is lava.

The landscape of CIRO has been sculpted from the upper parts of the Cassia batholith. Some of the oldest rocks in the western United States are found here. CIRO was designated a national natural landmark in recognition of the nationally significant geological and scenic values of its rock formations. Rock formations in the reserve developed through an erosion process called exfoliation, during which thin rock plates and scales sloughed off along joints in the rocks. The joints, or fractures, probably resulted from contractions when the rock cooled or from expansions when overlying materials eroded away and eliminated confining pressure. The granite has eroded into a fascinating assortment of domes and spires, some of which stand 200 feet or more above the surrounding landscape. Shallow depressions, called panholes, are scattered along the flat tops of many of the domes. The most notable panhole is located on top of Bath Rock and frequently fills with water from rain or snow melt. The degree to which wildlife depend upon these seasonal water holes is not known, nonetheless, these panholes contribute to the striking natural beauty of the reserve.

Hagerman Fossil Beds National Monument is located in Hagerman Valley in the central Snake River Plain. The Snake River, which flows west, then north, through the valley, forms the eastern boundary of the monument. On the monument side of the river, the valley wall rises steeply and abruptly about 550 feet above the river. Much of this steep terrain forms badland-type topography characterized by bluffs, landscape scarps, and hummocky deposits. The steep slopes consist of bluffs of the Glenns Ferry Formation. The bluffs, known locally as the Hagerman Cliffs, are composed primarily of unconsolidated lake, floodplain, and stream deposits, volcanic ash, and thin basalt flows deposited during the Pliocene and Pleistocene eras about 3.5 million years ago. On the eastern side of the river, where the monument headquarters is located, large basalt rimrock features define the valley wall, and large rounded boulders, called “melon gravel”, are scattered across the valley bottom. The melon gravel were deposited by pleistocene flood events caused by ice dams associated with glacial Lake Idaho.

<u>Walla Walla Plateau</u> – Nez Perce NHP, Lake Roosevelt NRA, and Whitman Mission NHS

The Walla Walla Plateau is a part of the Columbia Plateau and experienced much of the same flood basalt volcanism. Beginning about 15,000 years ago and continuing for about 2,800 years, periodic melting of glacial ice dams caused giant floods every 35 to 55 years (the last flood happened about 12,800 years ago). Geologists have documented up to 50 of these outbursts associated with glacial Lake Missoula and known as the Missoula Floods. These floods, documented as the largest in geologic history, each drained as much as 10 times the total combined volume of water carried today by all of the rivers in the world. When these walls of water hit the Wallula Gap, a narrows in the Columbia River downstream from the mouth of the Walla Walla River, water backed up and formed lakes in adjacent valleys and lowlands. In the

Walla Walla Valley, the water deposited fine-grained slackwater sediments created by the grinding layers of glacial ice that spread as far south as the current city of Spokane, Washington. These sediment depositions have been moved by wind (commonly called loess) and now cover the Palouse region of Washington and Idaho in rolling hills of deep loess soils. Geologists have recorded layers of volcanic deposits from eruptions of Mt. St. Helens interspersed between the layers of loess. The loess in the region is young from a geologic standpoint and quite rich in minerals. This mineral-rich deposit of loess, interspersed with volcanic ash, has led to the region becoming a highly productive agricultural region.

Blue Mountains Section – John Day Fossil Beds NM, Nez Perce NHP

The John Day Fossil Beds lie along the western edge of the Blue Mountains and share characteristics of both the Blue Mountains and the southern Columbia Plateau. Much of the Blue Mountains and Wallowa Mountains of northeastern Oregon and southeastern Washington are made of ancient accreted terrains that were smashed into the North American continental plate during eons of continental drift. During the Cretaceous Period, the Pacific Ocean extended east into central Oregon and deposited marine sediments. Subsequent subduction-related volcanism during the Eocene and Oligocene are largely responsible for the rich fossil resources in the region. These fossils record a much wetter and warmer climate that existed prior to the rise of the Cascade Range. Columbia flood basalts covered much of the region approximately 15 million years ago, and more recent volcanism, faulting, and water driven erosion have created a rugged modern-day landscape of deep rocky canyons, rimrock lined plateaus, and deeply eroded hills and gullies of pyroclastic sedimantary rocks and volcanic ash-derived clay soils. The plateaus along the lower reaches of the John Day Valley near the Columbia River were formed from the loess exposed by the Missoula Floods during the Pleistocene Epoch. Further south in the vicinity of JODA, Pleistocene influences are much less evident, and in this way the region differs considerably from the Walla Walla Plateau to the north. Mountain glaciers have been important further east in the Wallowa and Blue Mountains, carving out deep valleys, including the Wallowa Valley, the ancestral homeland of the Nez Perce and the burial site of Chief Joseph, an important part of NEPE.

Northern Rocky Mountains – Big Hole NB, Lake Roosevelt NRA

The Rocky Mountains took shape during a period of intense plate tectonic activity that formed much of the rugged landscape of the western United States. Three major mountain-building episodes reshaped the west from about 170 to 40 million years ago (Jurassic to Tertiary Periods). The last mountain building event, the Laramide orogeny, (about 70-40 million years ago) the last of the three episodes, is responsible for raising the Rocky Mountains.

During the last half of the Mesozoic Era, the Age of the Dinosaurs, much of today's California, Oregon, and Washington were added to North America. Western North America suffered the effects of repeated collision as slabs of ocean crust sank beneath the continental edge. Slivers of continental crust, carried along by subducting ocean plates, were swept into the subduction zone and scraped onto North America's edge. About 200-300 miles inland, magma generated above the subducting slab rose into the North American continental crust. Great arc-shaped volcanic mountain ranges grew as lava and ash spewed out of dozens of individual volcanoes. Beneath the surface, great masses of molten rock were injected and hardened in place.

For 100 million years the effects of plate collisions were focused very near the edge of the North American plate boundary, far to the west of the Rocky Mountain region. It was not until 70 million years ago that these effects began to reach the Rockies. The growth of the Rocky Mountains has been one of the most perplexing of geologic puzzles. Normally, mountain building is focused between 200 to 400 miles inland from a subduction zone boundary, yet the Rockies are hundreds of miles farther inland. Although geologists continue to gather evidence to explain the rise of the Rockies, an unusual subducting slab is believed to have largely driven the Laramide orogeny. At a “typical” subduction zone, an oceanic plate sinks at a fairly high angle. A volcanic arc grows above the subducting plate. During the growth of the Rocky Mountains, the angle of the subducting plate may have been significantly flattened, moving the focus of melting and mountain building much farther inland than is normally expected.

It is postulated that the shallow angle of the subducting plate greatly increased the friction and other interactions with the thick continental mass above it. Tremendous thrusts piled sheets of crust on top of each other, building the extraordinarily broad, high Rocky Mountain range

Both the Big Hole Valley and the Okanagan Highlands of upper Lake Roosevelt have experienced extensive reshaping from Pleistocene glaciation. Beginning about 2.5 million years ago and lasting until about 10,000 years ago, lobes of continental and cordilleran ice sheets ground across the Northern Rockies and the northern edge of the Columbia Plateau. The Big Hole Valley itself is a broad “U”-shaped valley carved by glaciers and the Okanagan Highlands were repeatedly smoothed over from periodic glacier movements.

Appendix B-6. Descriptions of major vegetation types within the Upper Columbia Basin Network.

Shrub-Steppe

Shrub-steppe habitat is found to some extent in all 9 network parks. The majority of shrubland habitat presented in Table 9 is shrub-steppe. Characteristic and dominant shrubs in the shrub-steppe vegetation type include several species of *Artemisia* sagebrush, at least three subspecies of *Artemisia tridentata* sagebrush, antelope bitterbrush, and 2 species of rabbitbrush. Each of these species may occur as ecological dominants in a monoculture-type condition, or may occur within a more complex heterogeneous shrub seral condition. Rabbitbrush, especially gray rabbitbrush, is associated with heavily disturbed areas.

A variety of native perennial and introduced annual grasses occur in association with sagebrush shrub species. Depending upon disturbance history, extensive stands of grasses can occur without a shrub component. Dominant grasses in the sagebrush-steppe of the UCBN include bluebunch wheatgrass, Idaho fescue, and Thurber's needlegrass. Sandberg or native bluegrass is often present in between caespitose clumps of the dominant bunchgrasses and basin wildrye often occurs in moist swales and drainages or along roadside ditches. Cheatgrass and other introduced invasive annual grasses are present, and frequently dominant, in many UCBN shrub-steppe habitats today. Ephemeral forb cover in shrub-steppe habitat is highly variable depending on annual precipitation, disturbance history, and other ecological factors. Forbs are always more present in the UCBN during years with average or above average precipitation. Trees may be present in some shrub-steppe habitats, usually as isolated individuals from adjacent forest or woodland habitats. For more information on shrub-steppe habitat descriptions, see the following link: http://www.nwhi.org/ibis/queries/wildhabs/WHDF_H16.asp.

Alteration of fire regimes, fragmentation, livestock grazing, and the addition of numerous exotic plant species have changed the character of shrub-steppe habitat in the UCBN. Overall this habitat has seen an increase in the diversity and abundance of exotic plants and a decrease in native bunchgrasses. More than half of the Pacific Northwest shrub-steppe habitat community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson et al. 1998). A number of unique and rare forbs are found within sagebrush-steppe habitats in the UCBN and a number are listed as state species of concern, including the picabo milkvetch and obscurre phacelia at CRMO.

Historically, sagebrush dominated shrub-steppe in the Columbia Basin experienced infrequent fires at intervals of 25 years or more (Barrett et al. 1997). Steppe vegetation in the region evolved in the absence of native grazers (i.e., bison), exacerbating the effects of domestic livestock introduction in the late 1800's (Bureau of Land Management 2002). Historic grazing and the introduction of invasive annual grasses has led to accelerated fire return intervals in many parts of the Columbia Basin, particularly in the Snake River Plain (Barrett et al. 1997, West and Young 2000, Wagner et al. 2003). Unlike the "hot" deserts of the southwestern U.S., in which a rich flora of native annuals coexists with the perennials, native annuals are extremely scarce or absent throughout much of the Great Basin and Columbia Basin (West and Young 2000, Wagner et al. 2003). Cheatgrass is one of the most widely distributed of the exotic annuals, currently estimated to dominate 20% of the intermountain shrub-steppe and it's introduction has led to significant changes in UCBN ecosystem structure and function (Mack and D'Antonio 1998, Wisdom et al. 2000, Keane et al. 2002).

Coniferous Forest and Woodland

Ponderosa pine forest only occurs in two of the northernmost parks of the UCBN, although it is widespread in the mesic foothills and montane environments surrounding many of the UCBN parks. Ponderosa pine occurs throughout the northern half of LARO and covers approximately 7% of NEPE. Scattered ponderosa pines occur around the margins of the lodgepole pine forest at BIHO and several large ponderosa pines are found in isolated draws in the Sheep Rock Unit of JODA. As in shrub-steppe, fire plays an important role in creating and maintaining the vegetation structure and composition in this habitat. The fire regime most often associated with ponderosa pine systems is the high-frequency/low intensity type described by Agee (1993) and Barrett et al. (1997) although this may not have been as widespread as was once believed (Baker and Ehle 2001). This fire regime is believed to have maintained ponderosa pine forests in open stands with single-layer canopies and shrub and grass understories (Hessburg and Agee 2003, Long 2003). Timber harvest, heavy livestock grazing, and fire suppression have led to widespread changes in the structure and composition of these forests (Long 2003). In the UCBN, the changes to ponderosa pine forest are most evident in LARO where the vegetation type is widespread in the northern portion of the park. Here, relatively dense stands of young pine occur with sparsely vegetated understories of antelope bitterbrush and other shrubs.

Juniper woodlands occur at JODA, CRMO, and are also present together with pinyon pine at CIRO. The vegetation type takes different forms in each of the three parks, occurring in widely scattered savannah-like woodlands in CRMO and parts of JODA, and in dense stands in CIRO and JODA. Pinyon-juniper woodlands often occur with shrub and grass understories. In JODA, many juniper stands have a dense understory of cheatgrass and other invasive annual grasses, including medusahead. Fire suppression, overgrazing, and climate changes are all factors that have apparently led to dramatic expansion of juniper out of fire protected draws and rimrock on to deeper soiled portions of sagebrush-steppe in much of the Columbia Basin (Miller and Rose 1999, Baker and Shinneman 2004, Soulé et al. 2004). This is evident at JODA and presents an ongoing management problem there. Juniper expansion is less evident at CIRO and CRMO and the vegetation type in these parks may more closely resemble historic conditions (Rust and Coulter 2000). Concerns of allelopathy have been raised for western juniper, which often does occur in monoculture-like conditions in some parts of the UCBN (Bureau of Land Management 2002). Efforts to control juniper expansion with fire and mechanical removal have become problematic because of post-treatment vulnerability to weed invasion (D'Antonio 2000). In spite of these concerns over expansion, pinyon-juniper and juniper woodlands provide important habitat for many species of vertebrates and invertebrates in the UCBN. Recent discovery of an outbreak of the pinyon *Ips* beetle at CIRO has presented a new and emerging threat to the pinyon-juniper vegetation there and will require close monitoring in order to determine an effective management strategy.

Lodgepole pine forest covers approximately 22% of the western portion of BIHO and is contiguous with extensive lodgepole and mixed conifer forest in the surrounding mountains of the Beaverhead National Forest. Also a fire-prone forest system, lodgepole forests are believed to have evolved within a high frequency/high intensity fire regime (Agee 1993). The serotinous seed cones of lodgepole pine illustrate this evolutionary relationship. Lodgepole pine seedlings have sprouted in much of the adjacent non-forested portions of the battlefield, and forest succession presents a significant management issue for the cultural landscape of the battlefield. The fire regime of lodgepole pine also implies a difficult and complex management dilemma for the battlefield, as a stand-clearing fire would dramatically alter the battlefield landscape.

Other coniferous vegetation in the UCBN include limber pine at CIRO and CRMO, and small pockets of Douglas fir, western larch, lodgepole pine, and small amounts of subalpine fir in CIRO, CRMO, BIHO and LARO. While these tree species are limited in distribution within the UCBN, they occur widely throughout mesic and montane regions of the Columbia Basin, and have important habitat value for the parks in which they occur. Limber pine occurs on Graham Peak in CIRO but is most significant at CRMO, where it occurs in many, isolated small stands in the northern portion of the monument. This species is considered a pleistocene relict by some investigators but this is not entirely clear (Schuster et al. 1995). Limber pine forms rather monotypic stands along the rocky exposed volcanic flats and north-facing slopes of cinder cones in CRMO. The patchy distribution of limber pine is reflective of its physiological requirements but also because its seeds are primarily dispersed by Clarks's nutcrackers, red squirrels, and other vertebrates (Schuster et al. 1995). Douglas fir occurs in wetter portions of LARO in mixed stands with western larch and ponderosa pine. It also occurs in small pockets along drainages in the extreme northern edge of CRMO, and it co-occurs with lodgepole pine at BIHO. Subalpine fir is present on top of Graham Peak at CIRO. Western larch is a unique component of the landscape at LARO and a species of concern due to its decline throughout the region (Hessburg et al. 2000).

<u>Deciduous Forest and Woodlands</u>

Aspen groves occur in isolated stands in CIRO, CRMO, BIHO, and LARO. These woodlands provide important habitat values and support cavity nesting birds and other vertebrates that would not remain in the parks in the absence of aspen (Lawler and Edwards 2002, Griffis-Kyle and Beier 2003, Parsons et al 2003). Aspen is a particularly important resource for cavity nesting birds and bats because of the structural characteristics that form in mature stands (Parsons et al. 2003). Marked declines in aspen have been noted throughout the intermountain west and have been the subject of much debate (Peet 2000). Fire suppression has been identified as the most widespread proximal factor, but elk browsing and domestic cattle grazing has also been recognized (Rogers 2002, Larsen and Ripple 2003). The status of aspen in the UCBN is not known, although regenerating suckers are present in many of the stands in CIRO and CRMO.

Other deciduous vegetation types include the cottonwood and willow galleries found along riparian areas in BIHO, HAFO, NEPE, and WHMI. At JODA, a unique wooded riparian habitat occurs along Rock Creek that consists of mountain alder. Throughout the region, these riparian woodlands have declined due to grazing, altered hydrology and stream morphology, and other anthropogenic causes (USDA Forest Service 1996, Quigley and Arbelbide 1997). These ecosystems are typically not subject to fire disturbance but have evolved within the context of floods and exhibit dispersal mechanisms and other characteristics well adapted to this type of disturbance (Knopf et al. 1988, Naiman et al. 2000). Typical of riparian areas in semi-arid biomes, the riparian woodlands of the network provide extremely valuable habitat for many species of vertebrates and invertebrates (Knopf et al. 1988, Knopf and Samson 1994). They also provide important ecological services, including flood control and bank stability (Knopf et al. 1988). Exotic deciduous woodlands, dominated by Russian olive, occur along riparian areas in HAFO and scattered Russian olive trees occur along Bridge Creek in the Painted Hills unit of JODA. While these invasives are generally considered undesirable and are subject to mechanical removal efforts at JODA, they do provide ecological value as well, including bank stabilization and wildlife cover.

Herbaceous Wetlands

Herbaceous wetland environments in UCBN parks make up a small percentage of land cover (see table 9) but are disproportionately important to biological diversity and ecological processes such as water retention and nutrient cycling (Gregory et al. 1991, Kauffman et al. 1997). Small seeps and springs are present in several UCBN parks, including JODA, CIRO, CRMO, HAFO, and JODA. A significant proportion of BIHO consists of riparian wetlands along the North Fork Big Hole River dominated by woody species such as willows, but extensive herbaceous wetland vegetation is present there as well. Herbaceous wetland vegetation is also present along riparian areas at HAFO, JODA, LARO, NEPE, and WHMI. No wetlands are present at MIIN. Herbaceous wetland vegetation in the UCBN ranges from small mossy areas in seep environments to extensive stands of sedges and rushes in seasonally inundated areas. In the UCBN, semi-arid climatic conditions prevail and transitions between wetland/riparian and upland areas are abrupt. Woody vegetation, usually willows, cottonwoods, and shrubs, delineate these areas. Sedges, rushes, and other herbaceous emergents dominate seasonally inundated areas within woody borders. American bulrush and various species of spike-rush and sedges are the most common species that occur in these conditions. The larger hardstem and softstem bulrushes also occur in several isolated wetlands in JODA and CRMO. The meander courses of the Big Hole River at BIHO provide for extensive stands of sedge-covered flood plains. Extensive stands of the introduced invasive grass, canary reed-grass, occur in many wetlands in the UCBN. Reed canary-grass is particularly abundant along the seasonally flooded portions of Lake Roosevelt, including the Kettle River arm of the lake, along Doan Creek in WHMI, along the John Day River in the Sheep Rock unit of JODA, and along the Snake River in HAFO. Canary reed-grass often forms dense monocultures that outcompete native vegetation and negatively affects riparian biodiversity. Reed canary-grass is not yet present in the Weippe Prairie site of NEPE nor along the Big Hole River in BIHO. Monitoring of these sites will be important for early detection and protection of these unique wetland sites.

Grassland

Grasslands in the UCBN primarily occur in conjunction with sagebrush-steppe. Grassland cover percentages in table 9 include areas of cheatgrass and bunchgrass dominated steppe. At HAFO, oldfields of crested wheatgrass occur in portions of the park and large stands of basin wildrye occur along the Snake River. Much of the grassland cover at BIHO consists of Idaho fescue steppe and broad stands of wet sedge meadows along the Big Hole River. In NEPE, highly altered grasslands are dominated by cultivated grasses and, in the case of White Bird Battlefield, converted shrub-steppe dominated by a variety of introduced annual and perennial grasses. WHMI contains the largest percentage of grassland in the UCBN, but the actual acreage represented by this is actually quite small (< 80 acres). The Walla Walla Valley was formerly dominated by Palouse prairie and the Cayuse name for the Whitman Mission site, “Waiilatpu”, has been translated to mean the “people of the rye grass”. The site today consists of areas of restored basin wild rye and perennial bunchgrass as well as extensive stands of reed canary-grass and other invasive species.

Agriculture

Various agricultural and livestock raising activities occur within and/or adjacent to all UCBN parks. Agricultural vegetation in the UCBN differs radically from adjacent native vegetation in structure and function. Vegetable crops are grown adjacent to HAFO, MIIN, and WHMI, and hay and alfalfa are grown within and around CIRO, JODA, NEPE, and portions of BIHO, CRMO, and LARO. Several UCBN parks are nearly surrounded by highly fragmented agricultural lands and they exist as islands of much more stucturally complex vegetation. This is particularly evident at HAFO and WHMI, and fragmentation and connectivity issues will continue to be of concern throughout the UCBN in the future.

Appendix B-7. Descriptions of fauna associated with the Upper Columbia Basin Network.

Vertebrates

Vertebrate communities associated with upper Columbia Basin habitats are well represented in UCBN parks. The fauna present in UCBN parks vary widely from site to site due to presence or absence of refugia, type of vegetation communities, and the presence or absence of water. Over 300 terrestrial vertebrate species were identified during the 2000-2003 inventories in the UCBN, including 24 species of reptiles and amphibians, 76 species of mammals, and over 200 species of birds. Current estimates, based on existing information, indicate that approximately 15-20 species of fish are also present in network waters. The bald eagle, bull trout, and middle Columbia ESU summer steelhead are the only confirmed vertebrates species listed as threatened or endangered in the UCBN (see Appendix D-4). However, there are many vertebrates listed as state and federal species of concern that occur in the UCBN, and many are unique to the semi-arid habitats of the upper Columbia Basin. This list includes unique species such as the greater sage grouse, pygmy rabbit, spotted bat, Columbia spotted frog, and western toad. One of the last strongholds of the arctic greyling south of Canada and Alaska is in the upper reaches of the Big Hole and North Fork Big Hole Rivers. The reach of the North Fork that passes through BIHO has not yet been evaluated for its importance to greyling.

As is typically demonstrated by species-area curves, vertebrate richness is highest in the large UCBN parks like CRMO and JODA, but unique habitats, such as the Mill Pond at WHMI and the open water at LARO, attract large numbers of migratory birds. Species richness by park varies most for amphibians and reptiles (Table 1). Amphibian populations may fluctuate widely over time and trends can be difficult to determine. Distribution and abundance of many amphibian species are more closely associated with specific substrates such as downed wood rather than vegetative cover. Also, most amphibian species require water which is scarce in the southern network parks.

Exotic species, such as bullfrogs, have eliminated amphibian species from some locations in network parks. Examples of this impact are evident at JODA, NEPE, and WHMI.

Table 1. Species Richness by taxon for network parks.

Park	Amphibians	Birds	Mammals	Reptiles
BIHO	2	83 (excluding winter)	31 (excluding bats)	2
CIRO	1	157	35	8
CRMO	4	206	45	10
HAFO	4	153	34	10
JODA	5	155	46	12
LARO	6	182	41	10
MIIN	NA	NA	NA	NA
NEPE	4	84 (excluding winter)	28 (excluding bats)	7
WHMI	3	202	27	5

The effect of livestock grazing or pesticide use on amphibians has not been studied in network parks. Some species of amphibians are known to be intolerant of these impacts. Irrigation is a use that is present in several network parks and it can be beneficial or detrimental, depending on local topography and seasonality of water level fluctuations. Irrigation can provide adequate habitat for egg laying or larval development, but if water is shut off to these areas prior to hatching or metamorphosis, reproduction is lost.

Reptiles in the UCBN are similar to amphibians in that they are not particularly associated with vegetation types. Reptiles require particular topographic conditions, such as a specific slope and aspect, and some species are associated with rock or particular ground cover conditions.

Some reptile species, currently listed as species of concern for network parks (Appendix D-4), may be associated with substrates or environmental characteristics that are not well distributed in the network. One example is the common garter snake which is widespread in distribution, but appears to be declining in parts of the network, including southeast Idaho (Charles R. Peterson, Idaho State University, personal communication).

Disturbance, land use practices, and invasion by exotic vegetation has altered the composition of sagebrush communities or led to extensive fragmentation and loss. The resulting changes in the structure and distribution of vegetation communities have influenced the distribution and abundance of many bird species. Species associated with native grasslands and shrublands, such as sage grouse, have declined dramatically (Paige and Ritter 1999). Sage grouse were historically present at JODA and in the southern portion of LARO, but the species is absent from these parks today (Sharp 1985, Hays et al. 1998). Birds breeding in sagebrush landscapes have been faced with radical and rapid changes in their habitats. Populations of shrubland and grassland birds have had the greatest rates of decline of any groups of birds (US Geological Survey 2002). Loss of reptile diversity may also be associated with the cheatgrass-dominated ground cover in sagebrush-steppe ecosystems. (Alan St. John, herpetologist, personal communication). Similar concern for vertebrate biodiversity have been noted in forested and riparian ecosystems as well (Wisdom et al. 2000). Region-wide changes in the structure and composition of forests have resulted in loss of nesting and roosting substrate for birds and bats (Pierson 1998, Hessburg et al. 2000). Availability of snags and downed wood at the landscape scale is of particular concern for LARO. Loss of riparian and wetlands in the upper Columbia Basin also threaten waterbirds, and the UCBN provides critical habitat for breeding, wintering, and migrating waterbirds (O'Connell 2000). In particular, Lake Roosevelt, the Mill Pond at WHMI, the John Day River at JODA, and the Snake River at HAFO are regularly used by large numbers of wintering and migrating waterfowl.

Range extensions or contractions for some species of vertebrates may be occurring in response to climate changes, climate-induced habitat changes, or other factors (Wagner et al. 2003). Some species of mammals found in the network, especially at CIRO, HAFO, and JODA, are at the northern limit of their range. During 2003 inventory work, the piñon mouse was confirmed in CIRO for the first time since an unvouchered report was made in 1967 (Larrison 1981). City of Rocks is at the northern limit of the range for this unique species. The species was also confirmed for the first time in the Clarno Unit of JODA, and represents the northernmost record for the species in the state of Oregon (Verts and Carraway 1998). In March of 2003, a ringtail was found dead in the Castle Rocks area of the Reserve by Idaho Department of Fish and Game personnel. This was the first record of the species in Idaho and also represents a significant northward range extension. A second dead ringtail was found in the Castle Rocks area in 2004 (Chuck Harris, Idaho Dept. of Fish and Game, personal communication). A similar northward range extension is also occurring for the northern mockingbird in JODA. Nesting mockingbirds in the Clarno Unit of JODA in 2002 represented the northernmost nesting record for that species in Oregon. Relict species at risk of range contractions include the pika at CRMO and the western whiptail at JODA.

Bats have emerged as a vertebrate order of interest in the UCBN because of the high proportion of mammalian diversity represented and because so many bat species are listed by state and federal authorities as species of concern. Although the conservation biology of bats in the Columbia Basin is not well developed (Marcot 1996), significant information has become available to the UCBN in recent years. Work done by Keller (1995, 1996, 1997) in CRMO and more recently by the UCBN through inventories and additional research (Rodhouse et al. in press) has demonstrated that several UCBN parks, especially CIRO, CRMO, JODA, and LARO are important centers of bat diversity and bat reproductive activity. In particular, maternity colonies of species such as the Townsend's big-eared bat and the pallid bat, both colonial roosting species sensitive to human disturbance, are concentrated in CRMO and JODA. These and other rock roosting species are likely concentrated at CIRO as well. The potential shortage of snags at LARO is a cause for concern because of the importance of snags as roosts for species like the silver-haired bat and the long-legged myotis.

UCBN parks provide important habitat for both breeding and wintering raptors. CRMO is particularly important, because of its size, for breeding and wintering buteo hawks, especially the ferruginous hawk, Swainson's hawk, and rough-legged hawk. Cooper's and sharp-shinned hawks regularly breed in the aspen and fir stands along the northern edge of the monument as well (Michael Munts, CRMO, personal communication). JODA has also been shown to be an important location for both breeding and wintering raptors. A survey of breeding raptors was conducted in 1977 (Janes unpublished) and the survey was repeated during inventory work in 2002 and 2003. Eight species of raptors, including four species of owls, were confirmed breeding in the monument in 2002 and 2003. The peregrine falcon was not confirmed breeding but sightings of adults were seen near the Cathedral Rock portion of the Sheep Rock Unit in 2002 and 2003, suggesting that a breeding pair may have become established on or near the monument. This would represent the first breeding pair to return to the lower John Day Valley since the era of DDT poisoning during the mid-20th century. Lake Roosevelt also provides important breeding habitat for peregrine falcons, bald eagles, and osprey.

While large carnivores do occur in several UCBN parks, large carnivores are not a focus of monitoring planning for UCBN parks because of the wide-ranging nature of these species. None of the network parks have been identified as having large, contiguous blocks of land that would serve as conservation areas for these species, although this may change in the future as fragmentation and land use change increases. UCBN parks are potentially important components of individual carnivore home ranges, and this will likely become more so as fragmentation and habitat loss increases on surrounding lands. Gray wolves occur in the Beaverhead Mountains adjacent to the Big Hole Valley and periodically range down along the North Fork Big Hole River through the battlefield. Gray wolves may also be ranging into the northern portion of CRMO, although this has not yet been confirmed. Wolves are also expected to colonize northeastern Oregon from Idaho during the next few years and JODA and the surrounding matrix of public and tribal land may become occupied by wolves in the future. Mountain lions occur in a number of parks, as do bobcat. Black bear are occasionally seen along the wooded margins and campgrounds of Lake Roosevelt.

Range extensions or contractions for some species of vertebrates may be occurring in response to climate changes, climate-induced habitat changes, or other factors (Wagner et al. 2003). Some species of mammals found in the network, especially at CIRO, HAFO, and JODA, are at the northern limit of their range. During 2003 inventory work, the pinyon mouse was confirmed in CIRO for the first time since an unvouchered report was made in 1967 (Larrison 1981). City of Rocks is at the northern limit of the range for this unique species. The species was also confirmed for the first time in the Clarno Unit of JODA, and represents the northernmost record for the species in the state of Oregon (Verts and Carraway 1998). In March of 2003, a ringtail was found dead in the Castle Rocks area of the Reserve by Idaho Department of Fish and Game personnel. This was the first record of the species in Idaho and also represents a significant northward range extension. A second dead ringtail was found in the Castle Rocks area in 2004 (Chuck Harris, Idaho Dept. of Fish and Game, personal communication). A similar northward range extension is also occurring for the northern mockingbird in JODA. Nesting mockingbirds in the Clarno Unit of JODA in 2002 represented the northernmost nesting record for that species in Oregon. Relict species at risk of range contractions include the pika at CRMO and the western whiptail at JODA.

<u>Invertebrates</u>

Very little is known about the invertebrate communities in UCBN parks. Lepidoptera and aquatic macroinvertebrate surveys were conducted in JODA in 2003 and 2004. Fifty-five species of butterflies and over 100 species of moths have been confirmed in JODA to date, including several rare species. Results from the macroinvertebrate survey are not yet available. The blind cave leiodid beetle, an Idaho state species of concern occurs in lava tubes of CRMO and two other species of concern, the Idaho pointheaded grasshopper and the Idaho dunes tiger beetle, likely occur in the park as well. Freshwater mollusks have not yet been inventoried in the UCBN but many species likely occur in streams and rivers throughout the network. As many as five species of state and federal mollusk species of concern may occur in the reach of the Snake River adjacent to HAFO, including the desert valvata, and the endemic Snake River physa and Bliss Rapids snail (Hovingh 2004). Numerous endemic mollusk species occur throughout the intermountain west and many have shown population declines and reduced distributions over the last 100 years (Hovingh 2004). An invasive non-native mollusk, the New Zealand Mudsnail, occurs in Lake Wolcott, 70 miles upstream from HAFO and poses a serious threat to native mollusks in the Snake River.

Although invertebrates are often overlooked in ecosystem management and planning efforts (FEMAT 1993, Niwa et al. 2001), the UCBN recognizes the importance of including invertebrates into long-term monitoring. Invertebrates drive many ecosystem processes, including energy and nutrient cycles, and may be excellent indicators of ecosystem health because of short generation times, high diversity, and, in many cases, tight coupling to ecosystem attributes such as vegetation, soils, water quality, and climate (Niwa 2001, Cummins et al. 2001).

Appendix C. Conceptual Ecological Models

C-1. Cultural Landscapes

A. Introduction

The historic and ethnographic landscapes of the UCBN pose a conceptual challenge for the natural resource monitoring program. Areas such as the Cant Ranch in JODA and the Ft. Spokane parade grounds at LARO are not readily incorporated into other focal system conceptual models such as forest and woodland or riparian and wetland, even though these landscapes may be surrounded by forest or contain riparian features. These landscapes represent only a small percentage of the total land area in the network, but tend to be disproportionately important to park management because of their significance to park enabling legislation and visitation. In several parks, cultural landscapes represent the entire park, making it even more imperative to address them in the conceptual modeling process. The UCBN has explicitly incorporated cultural landscapes into its vital signs monitoring program. We believe this will help ensure that the monitoring program is relevant to UCBN park management. It also will further our goal for integration, allowing for coordination of monitoring and management activities between cultural landscapes and adjacent "natural" landscapes.

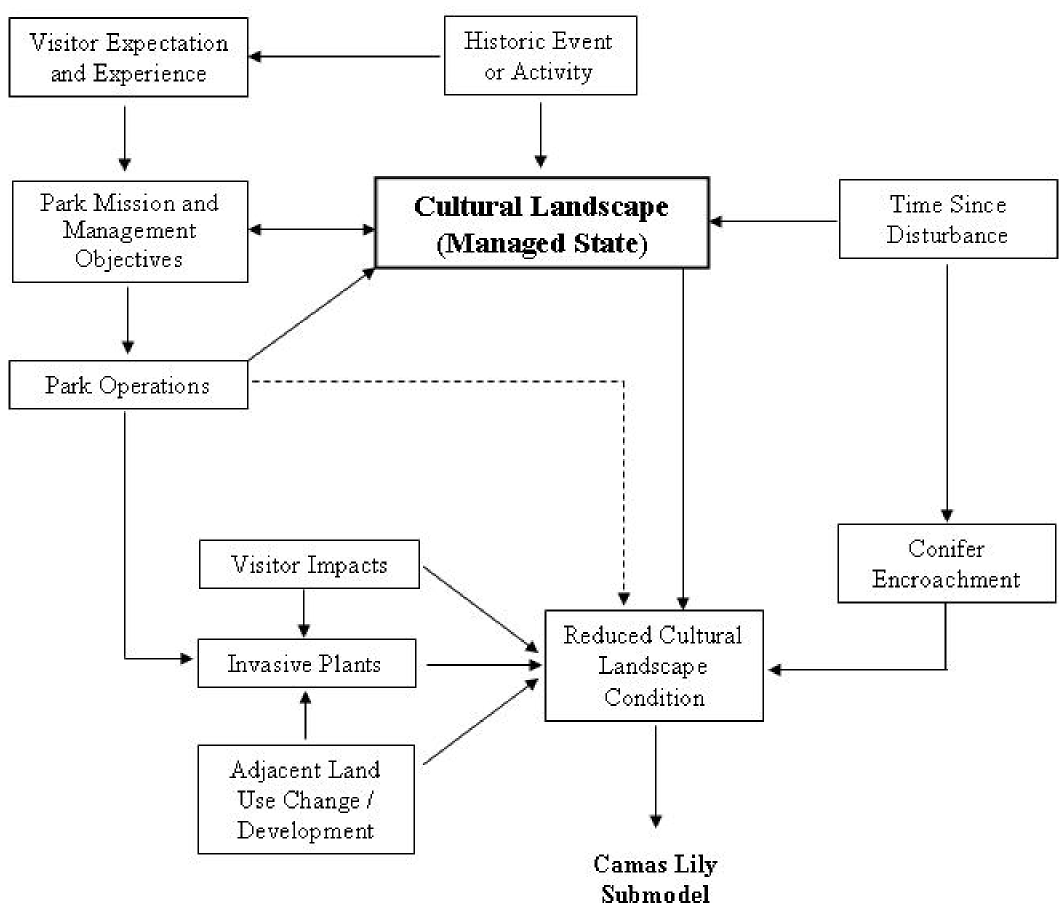
As a concept, the "cultural landscape" provides a useful ecological and logistical framework to organize vital signs and monitoring questions around. Viewed within an ecological context, cultural landscapes may often exhibit unique patterns and processes, especially in landscapes that are highly "governed" or managed to reflect a particular historical period (Bertollo 1998). Defining cultural landscapes and identifying boundaries between them and other landscapes, however, can be problematic (La Pierre 1997). On one hand, this can imply a split between humans and nature (Melnick 2000, Taylor 2002). Conversely, it can be so broadly defined as to include virtually all landscapes. For example, Taylor (2002) suggests that cultural landscapes can include any "landscape bearing the impact of human activity". This approach reflects the growing interest in ecology to incorporate an historical perspective and to recognize the importance of human influences on ecosystem development (Naveh 1982, Foster 2000). There is an equally growing interest among cultural scientists to incorporate an ecological perspective into the study of human-dominated landscapes (La Pierre 1997, Taylor 2002). We are in favor of this synthetic approach and are actively promoting the inclusion of human history into our conceptual models and monitoring strategies for other focal ecosystems. Likewise, we are attempting here to explicitly treat cultural landscapes as unique ecosystems integral to an effective and comprehensive monitoring program.

Howett (2000) suggests that the application of the term "integrity" as a value for cultural landscape preservation is dependent upon the recognition that such landscapes are dynamic and evolving, both in a biophysical sense and within the world of human values. What is considered desirable or historically relevant at one point in time may change as social values change. This notion can be extended to include "ecological integrity" (see glossary), which is also dependent both on an understanding that ecosystems are dynamic and that what is considered "appropriate" is a value-laden judgment. There is no reason, then, that cultural landscapes, even those intensively managed to reflect historical conditions, cannot be treated as dynamic ecosystems exhibiting the capability for self-renewal (Bertollo 1998, Foster 2002). The historical period to which a cultural landscape is managed is analogous to the idea of "future desired condition" frequently employed in ecological restoration (Cissel et al. 1999), albeit with a much tighter range of acceptable variation (La Pierre 1997).

Given that cultural landscapes are unique ecosystems, it is possible to identify important drivers, stressors, effects, and indicators of ecological integrity or, preferably, ecological condition. It is also possible to identify and monitor the influence of cultural landscapes on adjacent "natural" landscapes and vice-versa. This underscores the importance of considering cultural landscapes for an integrated monitoring program in the UCBN. Vital signs can be common to both cultural and natural ecosystems, and monitoring both can lead to a better understanding of their interrelationships, in turn leading to more efficient and effective resource management. The following sections present a general cultural landscape ecosystem control model, a submodel for camas lily (*Camassia quamash*) at NEPE and BIHO, and a narrative highlighting key model elements and relationships between them.

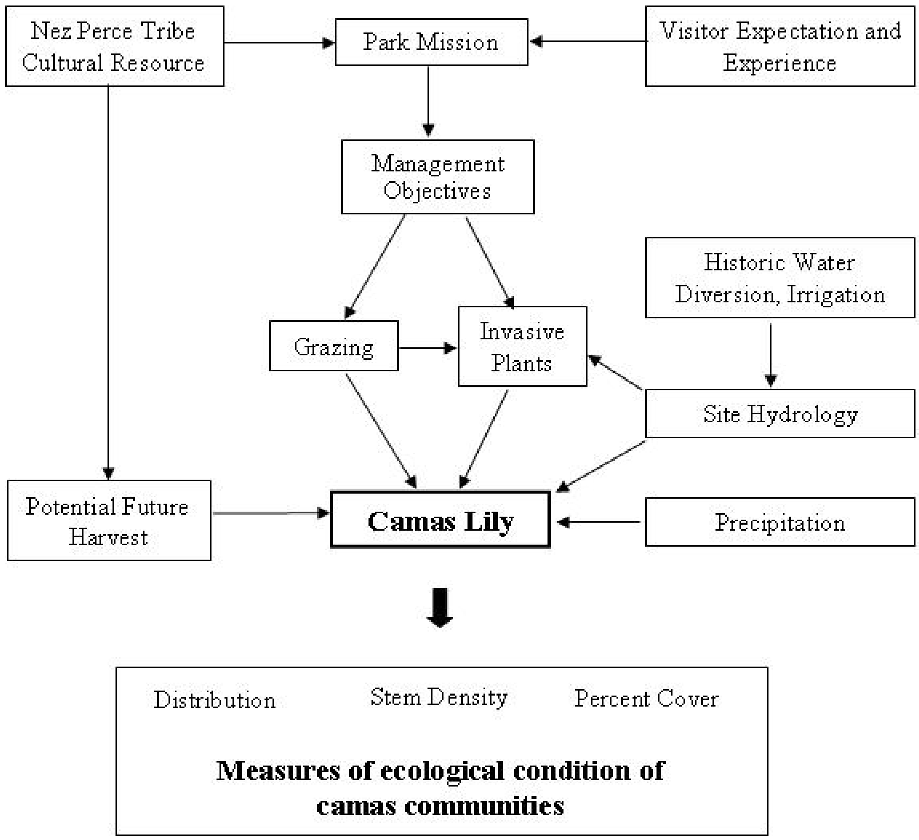
B. Cultural Landscape Ecosystem Control Model

Figure C-1. Relationships between the key drivers and stressors that exert fundamental controls on managed cultural landscapes. The dashed line represents a potential or hypothesized direct relationship between park operations and reduced condition.



C. Camas Lily Submodel

Figure C-2. Key drivers, stressors, and measures of camas lily community condition in NEPE and BIHO.



D. Cultural Landscape Models Narrative

Figures C-1 and C-2 illustrate the importance of both historical and contemporary human socioeconomic values in determining where and why cultural landscapes exist. By definition, cultural landscapes are dependent upon some type of historical use or activity, driven by human social or economic values. Likewise, their recognition and persistence are dependent upon contemporary values. In the UCBN, most cultural landscapes are managed to resemble the conditions as they existed at some point in the past. Typical of landscapes throughout the intermountain west, these were disturbance-driven systems and post-disturbance succession presents one of the most significant management issues facing UCBN cultural landscapes (Agee 1993, USDA Forest Service 1996). In BIHO, portions of the historic battlefield, an open steppe and wet meadow complex during the Nez Perce War of 1877, has been colonized by lodgepole pine from upslope forest, prompting a management response by the park in recent years. Forest structure has been identified as a vital sign for the BIHO cultural landscape. Similar phenomena are ongoing in the Ft. Spokane area of LARO and the California Trail at CIRO. Most UCBN cultural landscapes have been managed to remain within some narrow range of seral condition, either because of ongoing cultural use, such as hay cropping and grazing at Weippe Prairie, or because of park mission and management objectives related to maintenance of a particular historic condition.

Invasive plants are a significant issue in most UCBN cultural landscapes. Figures C-1 and C-2 illustrate how weedy plant invasions are exacerbated by visitation, historic and contemporary land use activities, and NPS management activities. Invasive species degrade ecological condition in cultural landscapes through their association with reduced native and desirable cultivated species, increased bare ground, surface runoff, soil erosion, and degraded viewshed. The intensive management and visitation at many cultural landscapes in the UCBN facilitates weedy plant invasions, and it is likely that some cultural landscapes are source localities for the spread of invasive species into adjacent ecosystems. Noteworthy examples include the dominance of non-native species at White Bird Battlefield in NEPE, and the ongoing efforts at native vegetation restoration in WHMI (National Park Service 2003a). In JODA, historic hay fields are maintained as part of the Cant Ranch historic vernacular landscape and contribute to weed infestation in adjacent sagebrush-steppe and riparian areas.

Figure C-2 illustrates the impacts of invasive plants on camas communities. Camas populations are significant at BIHO and at the Weippe Prairie in NEPE, where cattle are currently being used to control weed infestation until a more comprehensive management plan can be developed for the site. The camas lily communities at BIHO and NEPE have been selected as a focal resource vital sign in the UCBN monitoring program. Camas bulbs are an important traditional food for the Nez Perce people and it was during the camas harvest at Weippe Prairie when the Lewis and Clark Corps of Discovery first encountered the Nez Perce in 1805. A significant population of camas remains on the site despite over a century of farming and ranching. A central management focus for the site will be to enhance camas production. Current threats to the resource include invasive plants and an extensively altered stream channel and site hydrology. NEPE is working with the Natural Resources Conservation Service (NRCS) and local ranchers to allow limited grazing for weed control. The impacts of cattle on camas have not been evaluated in the site. The possibility of allowing limited ceremonial harvest of camas at Weippe Prairie by Nez Perce tribal members has also been raised. At BIHO, the camas community has been less impacted by historic activities and site hydrology has not been as significantly altered. However, non-native plant invasion is an important concern. Management and monitoring at this site will focus on camas community persistence rather than on increasing production.

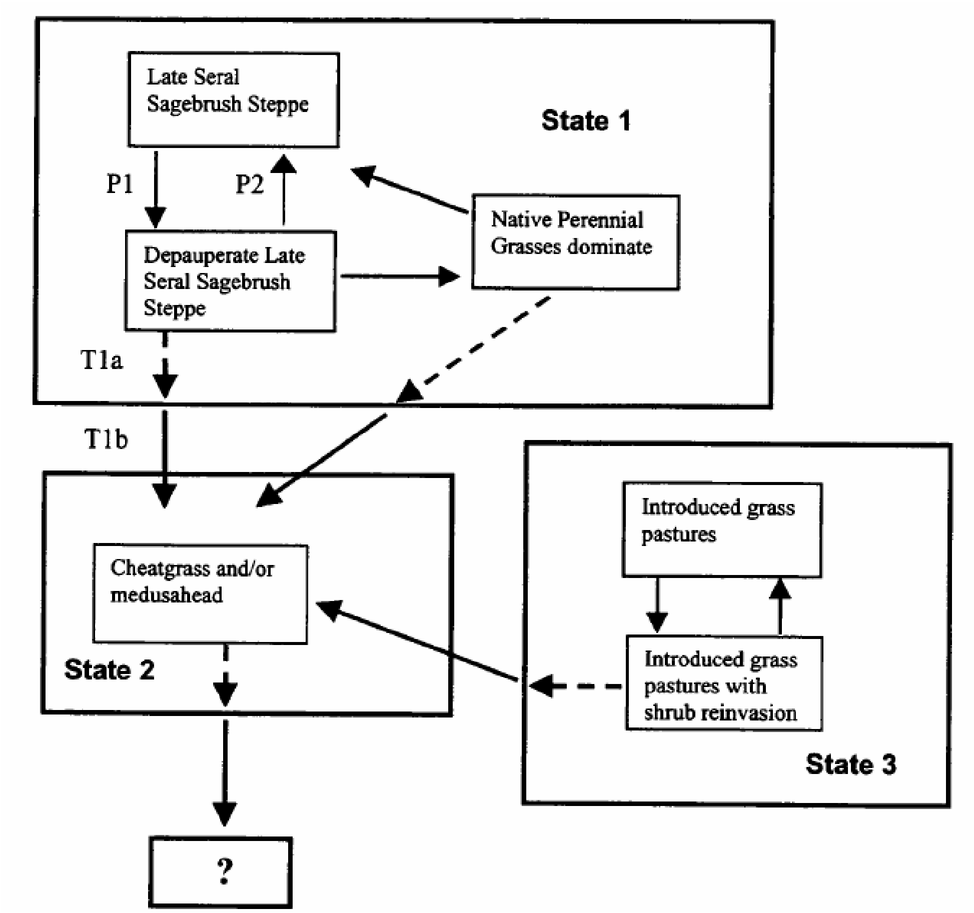
C-2. Sagebrush-Steppe Ecosystems

A. Introduction

The sagebrush-steppe region has undergone radical and extensive changes during the last 150 years (USDA Forest Service 1996, West and Young 2000, Bureau of Land Management 2002, Reid et al. 2002). Prior to European colonization, sagebrush-steppe covered approximately 44 million hectares of the intermountain west (West and Young 2000). Significant portions of the region have since been converted to agriculture and heavily grazed rangeland (West and Young 2000, Bunting et al. 2002). Much of the remaining sagebrush-steppe has been degraded through altered fire regimes and invasion of introduced plants (Reid et al. 2002). These changes have had significant impacts on the ecological condition of the sagebrush-steppe, including a decline in native flora and fauna, decreased soil stability, and reduced hydrologic function (Mack and D'Antonio 1998, Wisdom et al. 2000, Keane et al. 2002).

One of the most significant changes in this ecosystem has been the arrival of cheatgrass and the subsequent shift in fire frequencies (Mack 1981, Yensen 1981, D'Antonio and Vitousek 1992). This has emerged as one of the paramount examples of state transitions, in which the sagebrush-steppe state crosses a "threshold" into a new state dominated by cheatgrass (Stringham et al. 2001). The resulting increase in fire frequency prevents reestablishment of sagebrush and a return to the former state. State transition models have been widely used to represent this kind of ecological phenomena and they have been especially helpful in their ability to accommodate multiple successional pathways and steady states (Tausch et al. 1993, Stringham et al. 2001). Figure C-3 shows the state transition model proposed by Stringham et al. (2001) for sagebrush-steppe. In this figure, multiple pathways are shown, represented by arrows inside state boxes, as well as multiple transitions between states. Although fire as an agent of transition is not explicitly represented in this model, it is applicable to many of the sagebrush-steppe environments in UCBN parks. States 1 and 2, conditions in which native steppe vegetation and cheatgrass dominate, are the most prevalent. However, old fields of crested wheatgrass pastures with varying degrees of shrub reinvasion and transition to annual grass dominance do occur at HAFO and JODA.

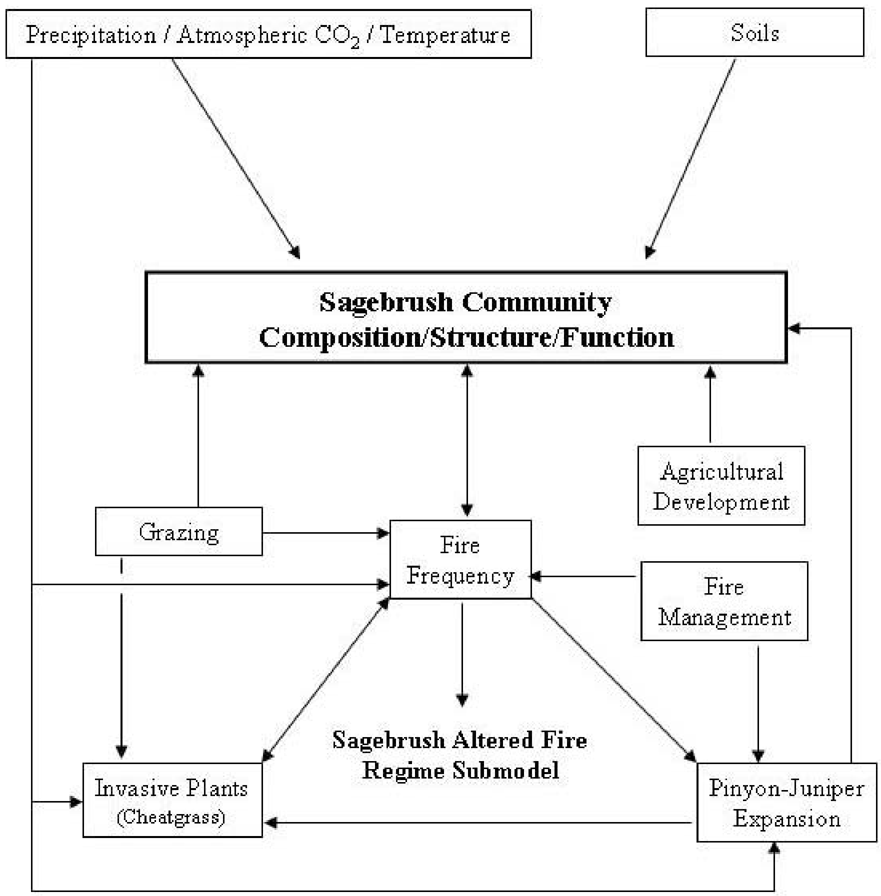
Figure C-3. Sagebrush-steppe state and transition model proposed by Stringham et al. (2001).



The sagebrush-steppe ecosystems of the UCBN have been affected by this altered fire regime to varying degrees and, because it is such a synoptic phenomenon, it has emerged as a central focus of our conceptual models. There are, however, a number of other important issues to consider, including the legacy of grazing, agricultural conversion, and the expansion of pinyon-juniper woodland into park steppe landscapes. The following sections present a set of nested conceptual models and accompanying narrative developed for UCBN sagebrush-steppe ecosystems highlighting key community dynamics and measures of sagebrush community condition.

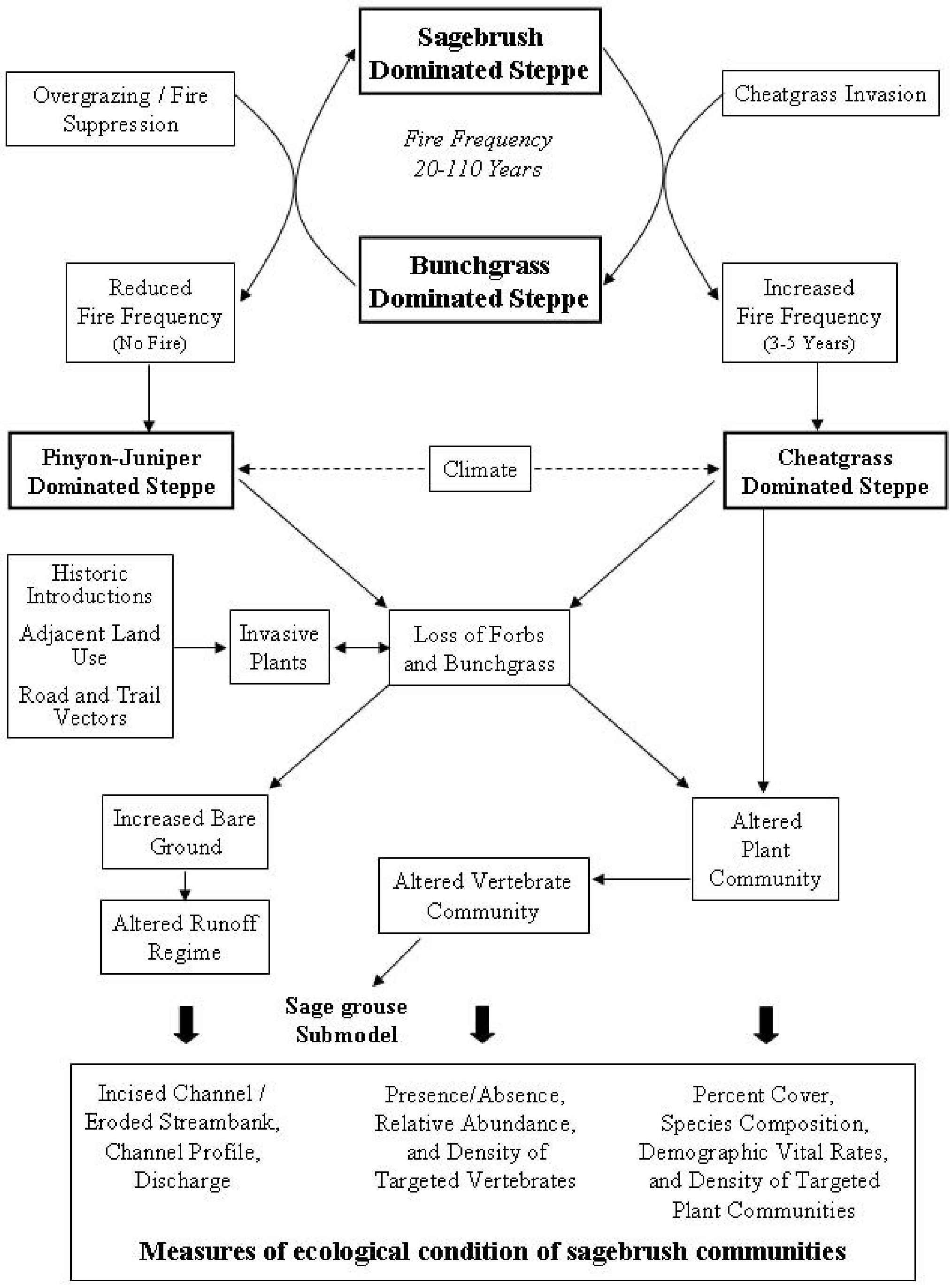
B. Sagebrush-Steppe Ecosystem Control Model

Figure C-4. Primary natural and anthropogenic controls on the composition, structure, and function of sagebrush-steppe in the UCBN.



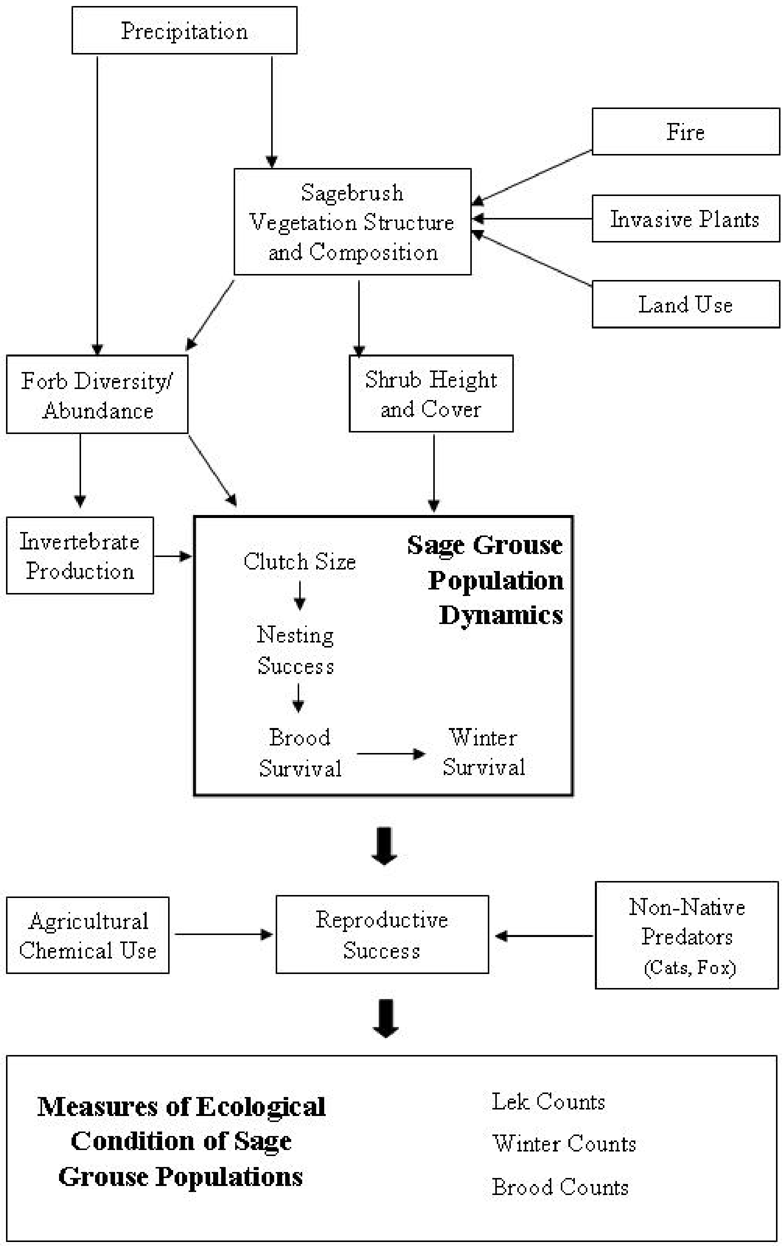
C. Sagebrush-Steppe Altered Fire Regime Submodel

Figure C-5. Fire-driven community dynamics in sagebrush-steppe. The dashed lines represent hypothesized relationships.



D. Sage grouse population dynamics submodel

Figure C-6. Fundamental drivers of and stressors on sage grouse population dynamics.



E. Sagebrush-Steppe Models Narrative

As is indicated in Figure C-4, weather, climate, soils, and fire are the most fundamental drivers of sagebrush-steppe ecosystems (Reid et al. 2002). Precipitation is the most important aspect of weather and climate influencing sagebrush-steppe, but temperature is extremely influential in evapotranspiration, and atmospheric CO_2 is emerging as a potential contributor to increasing invasive species and pinyon-juniper expansion (Smith et al. 2000). This is indicated in Figure C-5 by the dashed line between climate and juniper and cheatgrass dominated steppe. The precipitation gradient, itself influenced by elevation and regional climate patterns, determines the distribution of sagebrush-steppe within the UCBN. Sagebrush-steppe is bounded by salt desert shrub vegetation at the lower range of precipitation and in poorly drained alkaline playas and is bounded by coniferous woodland and forest at the upper end of precipitation (West and Young 2000). Sagebrush-steppe typically occurs in valley bottoms and lower mountain slopes where annual precipitation ranges from 18cm-40cm for basin big sagebrush and 26cm-60cm for mountain big sagebrush (Bureau of Land Management 2002).

Precipitation coupled with soil texture, soil depth, site drainage, and soil moisture dictate the distribution of sagebrush species and subspecies, which have been grouped into vegetation "alliances" (Reid et al. 2002). These sagebrush alliances exhibit important differences in ecosystem dynamics, including resistance and resiliency to disturbances (Bureau of Land Management 2002, Reid et al. 2002). Sagebrush-steppe occurs within a relatively broad range of soil types and depths but subspecific affinities are exhibited within this range. The sagebrush subspecies as well as the presence and density of other shrubs, such as rabbitbrush and horsebrush, are important factors in steppe ecosystem development and response to drought, fire, and other disturbances. Table C-1 shows the major sagebrush species and big sagebrush subspecies of the UCBN and the primary soil-moisture and fire regime characteristics of those alliances.

Fire frequency is a critical driver in sagebrush-steppe ecosystems of the UCBN, but this is largely constrained by precipitation, soil, and sagebrush alliance type (Reid et al. 2002). Figure C-5 illustrates the interrelationships between fire frequency, climate, and sagebrush community or alliance type. Table C-1 describes the connection between alliance type, soil moisture, and fire regime. Fire return intervals are longest on dry sites and shortest on mesic sites. The grass and forb component of sagebrush-steppe acts as fine fuels when dry, and mesic mountain big sagebrush sites generally produce more fine fuels than drier alliances, in turn driving more frequent fires. Inter-annual variation in precipitation also influences fire frequency within alliance types, with wet years producing more fine fuels and more fire.

Given the extent to which current fire return intervals are outside the historical range of variability, fire has also become a significant stressor on sagebrush-steppe ecosystems (D'Antonio and Vitousek 1992, D'Antonio 2000, Keane et al. 2002). This is particularly evident when placed within the context of the cheatgrass-driven altered fire regime of sagebrush-steppe illustrated in Figure C-5. Dry alliances, particularly that of Wyoming big sagebrush, tend to be most susceptible to cheatgrass invasion and altered fire regimes. Recovery from fire also tends to be slower in dry alliances, and drought conditions can further inhibit recovery. Reestablishment of sagebrush following fire in Wyoming big sage alliance types can be particularly slow during drought conditions (Bureau of Land Management 2002). Although not yet quantified, low elevation steppe habitats of CRMO, HAFO, and JODA are clearly more impacted by cheatgrass than the higher elevation steppe of CIRO and the northern portion of CRMO.

Table C-1. Soil-moisture and fire regime characteristics associated with sagebrush (Genus *Artemisia*) species and big sagebrush (*Artemisia tridentata*) subspecies "alliances" in the UCBN (from Bureau of Land Management 2002 and Reid et al. 2002).

Species	Common Name	Elevation (m)	Soil
A. arbuscula	low sagebrush	900-3500	rocky, shallow
A. tripartita	threetip sagebrush	900-3000	moderate to deep, loamy to sandy
A. tridentata wyomingensis	Wyoming big sagebrush	1500-2000	deep, coarse to fine
A. t. tridentata	basin big sagebrush	250-3000	deep, coarse to fine
A. t. vaseyana	mountain big sagebrush	1400-3000	deep, coarse to fine

Species	Fire Tolerance	Fire Return Interval	Moisture Regime
A. arbuscula	intolerant	long, 50+	dry
A. tripartita	resprouter	medium, 20-50	semi-dry
A. t. wyomingensis	intolerant	long, 50+	dry
A. t. tridentata	intolerant	medium to long, 20-100	semi-dry
A. t. vaseyana	intolerant	short, 10-25	semi-dry to mesic

There is considerable unanimity within the scientific community as well as within the UCBN management community regarding the significance of non-native invasive plants in sagebrush-steppe ecosystems (USDA Forest Service 1996, Bureau of Land Management 2002, Reid et al. 2002). Cheatgrass, medusahead, thistles, and knapweeds, to name a few, are actively spreading throughout the network and are having profound impacts on park ecosystems (Yensen 1981, USDA Forest Service 1996). UCBN park managers have consistently ranked this as their top resource concern and monitoring of sagebrush-steppe communities will be closely tied to management objectives and activities related to invasive species. The spread of exotics are linked with other stressors of concern, including historic overgrazing, adjacent agriculture, expanding woodlands, and prescribed fire. Recent predictions of climate change scenarios have provided evidence that elevated temperature and atmospheric CO_2 concentrations may further facilitate the spread of certain exotic species, including cheatgrass (Smith et al. 2000, Wagner et al. 2003). Figure C-5 illustrates this hypothesized relationship with a dashed line.

Mismanaged grazing ranks near the top of significant sources of ecological change in sagebrush-steppe, although it has had less of an impact in the UCBN than is generally the case elsewhere in the public lands of the region (USDA Forest Service 1996, Bunting et al. 2002). Currently, only LARO, NEPE, and CIRO permit allotted grazing inside park boundaries, but historic grazing effects are still influential in CRMO, HAFO, JODA, and NEPE. Heavy historic grazing has contributed to a reduction in fire frequency, leading to structural changes in sagebrush-steppe (see Figure C-5; Belsky 1996, Keane et al. 2002, Soulé et al. 2004). The expansion of pinyon pine, western juniper, and rocky mountain juniper woodlands into sagebrush-steppe has been linked to grazing-induced altered fire regime, although the sources and impacts of this invasion on ecological condition are not entirely clear (Belsky 1996, Miller and Rose 1999, Gedney et al. 1999, West and Young 2000). Climate change has also been identified as a source of pinyon–juniper expansion in the region (Soulé et al. 2004). In the UCBN, the issue of conifer expansion into steppe is limited to JODA and CIRO, and is of particular relevance at JODA.

Altered fire regimes, historic overgrazing, and invasive plant species have led to widespread qualitative degradation of sagebrush-steppe vegetation that, in concert with quantitative loss of steppe through agricultural conversion, have led to second-order changes in surface water dynamics and loss of sagebrush-obligate vertebrates (Figure C-5; Dobkin 1995, Noss et al. 1995, USDA Forest Service 1996, National Research Council 1996, Quigley and Arbelbide 1997, Kauffman et al. 1997, Wisdom et al. 2000). Network priority vital signs include sagebrush-steppe vegetation, sage grouse, and surface water dynamics and channel/bank morphology.

Figure C-5 illustrates how altered fire regimes and plant invasions have led to a cascade of biophysical effects from increased bare ground to reduced capacity for infiltration, increased surface runoff, reduced water storage capacity, lowered water table, and, ultimately, degraded stream channel morphology (Bureau of Land Management 2002, Bunting et al. 2002, Keane et al. 2002). Degradation of riparian ecosystem integrity has been particularly acute in sagebrush-steppe ecosystems (National Research Council 1996, Quigley and Arbelbide 1997, Kauffman et al. 1997). Because the sagebrush-steppe is a semi-arid environment, the narrow riparian zone along waterbodies in UCBN steppe environments were quickly overgrazed during historic times (Todd and Elmore 1997). Loss of riparian vegetation, as well as changes in surface water dynamics across adjacent uplands, caused rapid and dramatic downcutting or “incising” of stream channels during the early 20th century throughout the upper Columbia Basin (Todd and Elmore 1997, Kauffman et al. 1997). Dramatic changes in water quality and streambed substrates resulted, and in turn resulted in widespread loss of fish-rearing habitat throughout the Basin (National Research Council 1996, Quigley and Arbelbide 1997). In the UCBN, most sagebrush-steppe waterbodies are in some stage of recovery from historic stressors.

The sage grouse is particularly representative of tight coupling between steppe obligate vertebrates and vegetation composition and structure (Figure C-6; Connelly et al. 2000). Reproductive success of sage grouse depends on sagebrush shrub height and cover, diversity of spring forbs, and abundant invertebrates (Connelly et al. 2000). Historic and contemporary land use, including grazing, fire, and plant invasion all impact vegetation composition and structure in profound ways as previously discussed. Sage grouse frequently use agricultural lands during late spring and summer as adjacent steppe dries out, and in turn become susceptible to agricultural chemicals (Connelly et al. 1988, Blus et al. 1989). Feral cats and red fox have also been implicated in increased sage grouse mortality in some parts of their range (Flinders 1999, Connelly et al. 2000). Sage grouse were historically present at JODA and in the southern portion of LARO, but the species is absent from these parks today (Sharp 1985, Hays et al. 1998). The species has likely been extirpated from HAFO. Sage grouse are present in CRMO and CIRO and coordinated monitoring with IDFG and BLM is anticipated in those parks.

C-3. Forest and Woodland Ecosystems

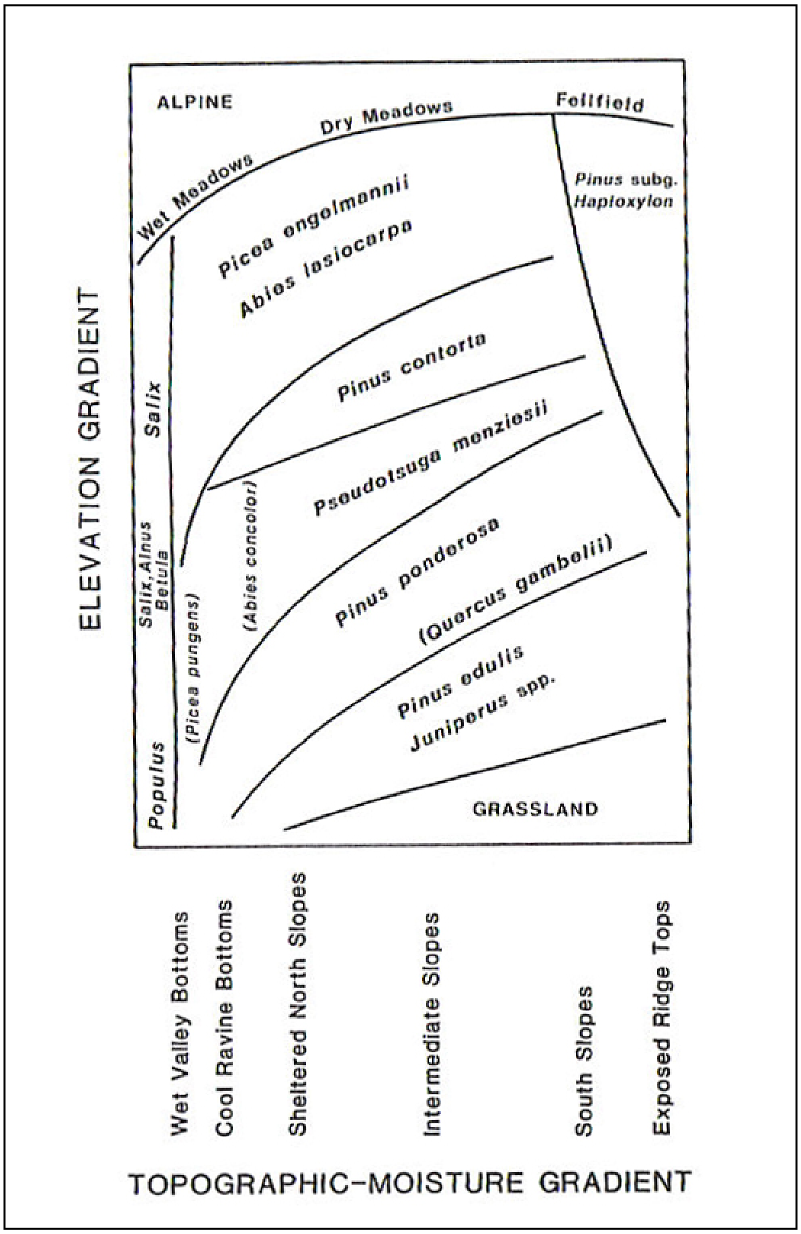
A. Introduction

As is the case throughout the intermountain west, the forests and woodlands of the UCBN are disturbance driven ecosystems (Peet 2000). Fire is the most widespread and significant disturbance agent in the region, but insects pest outbreaks are becoming increasingly important and are also highlighted in the folowing conceptual models (Hessburg and Agee 2003, Long 2003). The ecology of distubance in our forests and woodlands is extremely complex and the developing science around this topic is in a state of flux and uncertainty (Simberloff 1999, Baker and Ehle 2001, Long 2003, Baker and Shinneman 2004). While this uncertainty creates an exciting and dynamic research environment, it poses a difficult challenge to UCBN managers. This situation underscores the need for long-term monitoring (see Simberloff 1999) in the network, and it is hoped that the UCBN monitoring program will be able to generate information on the disturbance ecology of network forests that will be useful to managers.

Much of the current uncertainty surrounding disturbance in the forest systems of the intermountain west stems from the complexity of edaphic conditions and environmental gradients found there (Peet 2000, Long 2003). Across the region, latitude, elevation, topographic position, and parent material all strongly influence the distribution and the characteristics of forests and woodlands (Long 2003). Each of these factors are influential in the UCBN and the most influential, elevation and topography, occur along gradients that are the fundamental controls on where forests occur and on the types of disturbances that occur there (Peet 2000). Elevation itself influences precipitation, temperature, and other environmental variables crucial to plant distribution. In general, an increase in elevation leads to an increase in precipitation, solar radiation, and wind, and a decrease in temperature (Peet 2000). Topography, via slope and aspect, strongly influences soil moisture and temperature – a phenomenon frequently referred to as the “topographic moisture gradient” (Whittaker 1967, Peet 2000, Long 2003). The influence of these drivers on forest disturbances is profound and, given the elevational and topographic variability in the intermountain region, quite complex. Figure C-7 illustrates the relationship between elevation and topographic moisture gradients. Of particular note in the figure is the diagonal orientation of the vegetation types, which tend to occur at increasing elevation as sites become drier.

Elevation and topographic moisture gradients interact with synoptic climate patterns to strongly influence the frequency and severity of disturbances (Long 2003, Meyer and Pierce 2003). With fire disturbance in particular, these influences constrain vegetation type, fuel accumulation, soil moisture, and other site characteristics that determine fire regimes. Insect pest outbreaks are also linked to fire and topographic moisture gradients in complex ways.

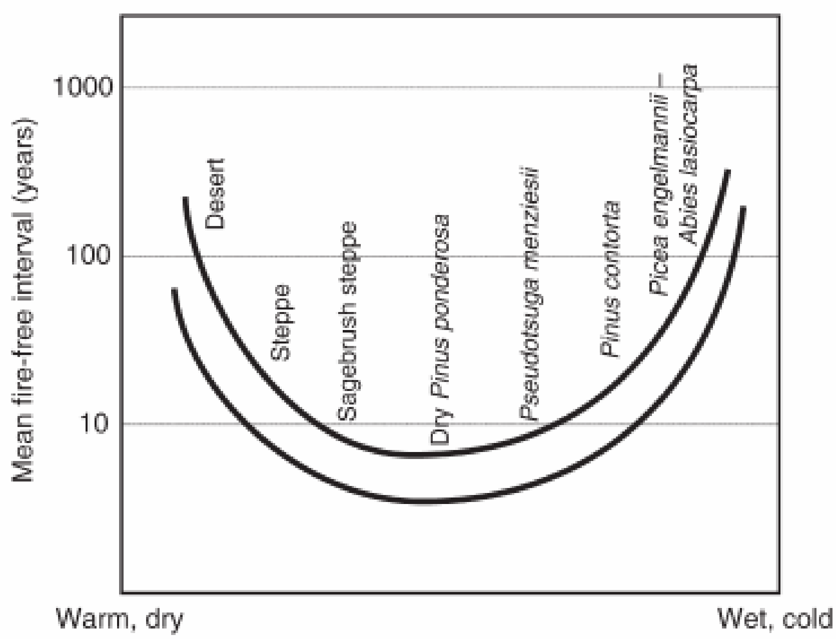
Figure C-7. The generalized relationship between elevation and topographic moisture gradients and their influence on the distribution of forest and woodland vegetation (Peet 2000).



With the exception of limber pine communities, both the presence and absence of fire is a central focus for the UCBN forests and woodlands conceptual models. These ecosystems developed under the influence of fire and are today all at some stage of succession resulting from fire (Peet 2000). Many of the management issues in the network, such as the density of pine stands at LARO and of juniper woodlands at JODA, are closely connected to historic patterns of fire frequency and intensity. In particular, fire absence has been identified as a major factor in the decline of forest health in the region (Tiedemann et al. 2000). Fire suppression and overgrazing have been attributed to an increase in stand density and fuel accumulations, making forests more susceptible to large, catastrophic fire and insect outbreaks (Johnson 1994, Tiedemann et al. 2000). Fire suppression is also attributed to declining rates of aspen regeneration and expansion of pinyon-juniper woodland into adjacent sagebrush-steppe (Miller and Rose 1999, Gedney et al. 1999, West and Young 2000, Rogers 2002).

Our understanding of fire suppression in UCBN forests and woodlands is framed by the generalized fire regimes that have been developed for Pacific Northwest forests (Martin and Sapsis 1991, Agee 1993). Figure C-8 shows the relationship between fire frequency, topographic moisture, and forest vegetation that guides the research and management discourse on fire ecology in the region. In general, low elevation mesic sites dominated by ponderosa pine are believed to have experienced frequent low severity fires, while higher sites with increasing moisture as well as drier sites with slower rates of fine fuel accumulation typically experienced less frequent higher severity fires (Agee 1993, Peet 2000). In this context, severity refers to damage to crown structure, with the highest severity fires resulting in stand replacement (Long 2003). Accordingly, fire suppression has been most important in high frequency ponderosa pine systems in which several fire cycles have been skipped during the post-settlement era beginning in the late 19th century (Long 2003). A number of dendrochronology and fire-scar studies have demonstrated this altered fire regime in ponderosa pine forests of eastern Washington (Everett et al. 2000, Ohlson and Schellhaas unpublished). Increased stand density, increased presence of shade tolerant firs, insect pathogen infestation, and increased fire severity are some of the resulting changes in ecosystem structure and function (Peet 2000). Similar studies have shown fire suppression to be a factor in pinyon-juniper and aspen ecosystems, resulting in altered stand structure and function (Rust and Coulter 2000, Rogers 2002). In the UCBN, limber pine stands are restricted to sparsely vegetated rocky environments that rarely experienced fire.

Figure C-8. Fire frequency, elevation/topographic moisture gradients, and forest vegetation in the intermountain west (Long 2003).

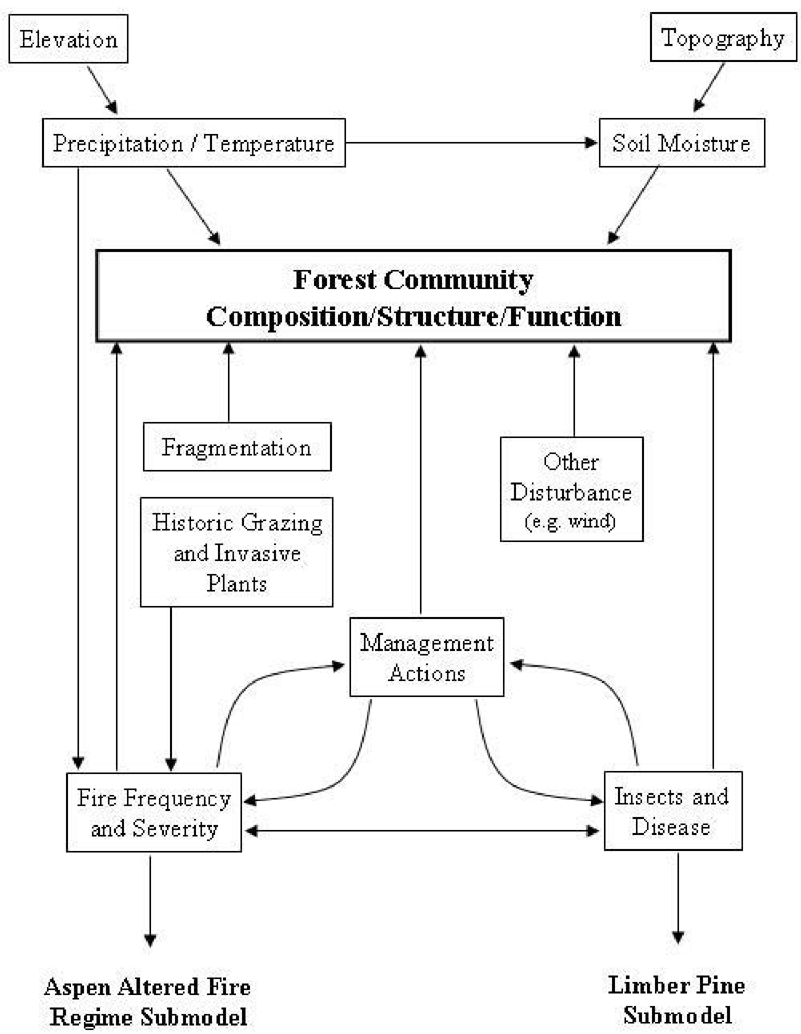


While the generalized relationships illustrated in Figure C-8 remain the dominant paradigm for fire ecology in the west today, a number of investigators have questioned the universality of this paradigm and recent data have introduced an element of uncertainty into the discussion. For example, Baker and Ehle (2001) and Baker and Shinneman (2004) urge caution in the interpretation of fire-scar studies in ponderosa pine and juniper systems and suggest that fire frequencies in these systems may have been much longer than currently believed. Whitlock et al. (2003), Meyer and Pierce (2003), and Soulé et al. (2004) show that periods of increased and decreased fire activity in northwest forests and woodlands correspond to global warming and cooling trends and that anthropogenic suppression, while an important factor, may be less so than previously believed. Grappling with these issues of uncertainty will be important in the UCBN because of their implications for NPS policy and management. Today there is great interest in using an understanding of historic disturbance regimes to design ecosystem management (Wallin et al. 1996, Cissel et al. 1999, Franklin et al. 2002), however, the historic picture is still emerging, many questions remain unanswered, and conservative management approaches and accompanying monitoring are recommended (Simberloff 1999, Tiedemann et al. 2000). The prospect of future climate change adds additional complexity, and it is likely to significantly alter forest disturbance regimes (Logan and Powell 2001).

The following sections present conceptual models and a brief narrative highlighting key relationships in forest and woodland community dynamics in the UCBN. The models focus on altered distrubance regimes and are constructed with the explicit recognition that contemporary UCBN forest and woodlands developed upon a complex legacy of historic disturbance and a mosaic of biophysical characteristics that are not fully understood.

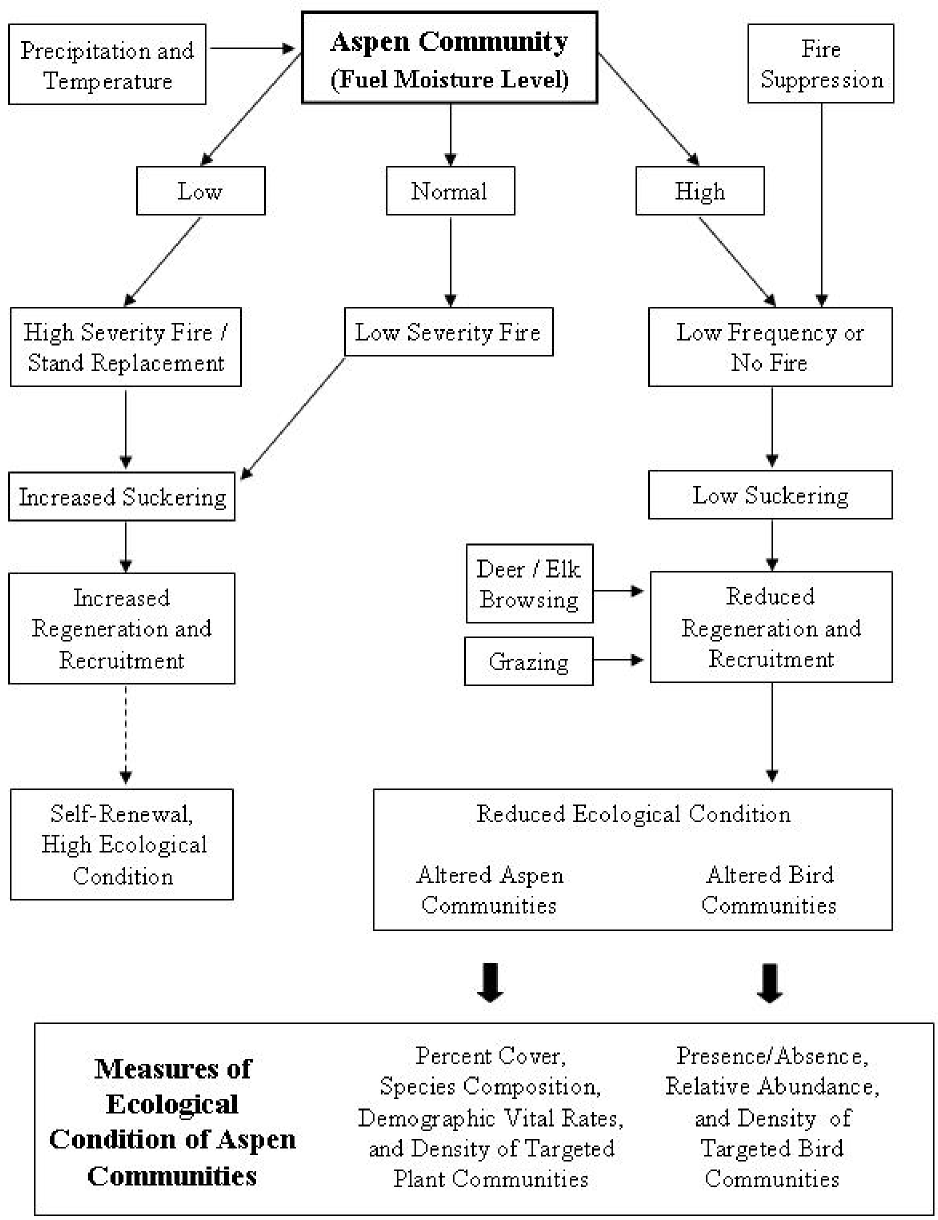
B. Forest and Woodland Ecosystem Control Model

Figure C-9. Primary drivers of forest community composition, structure, and function.



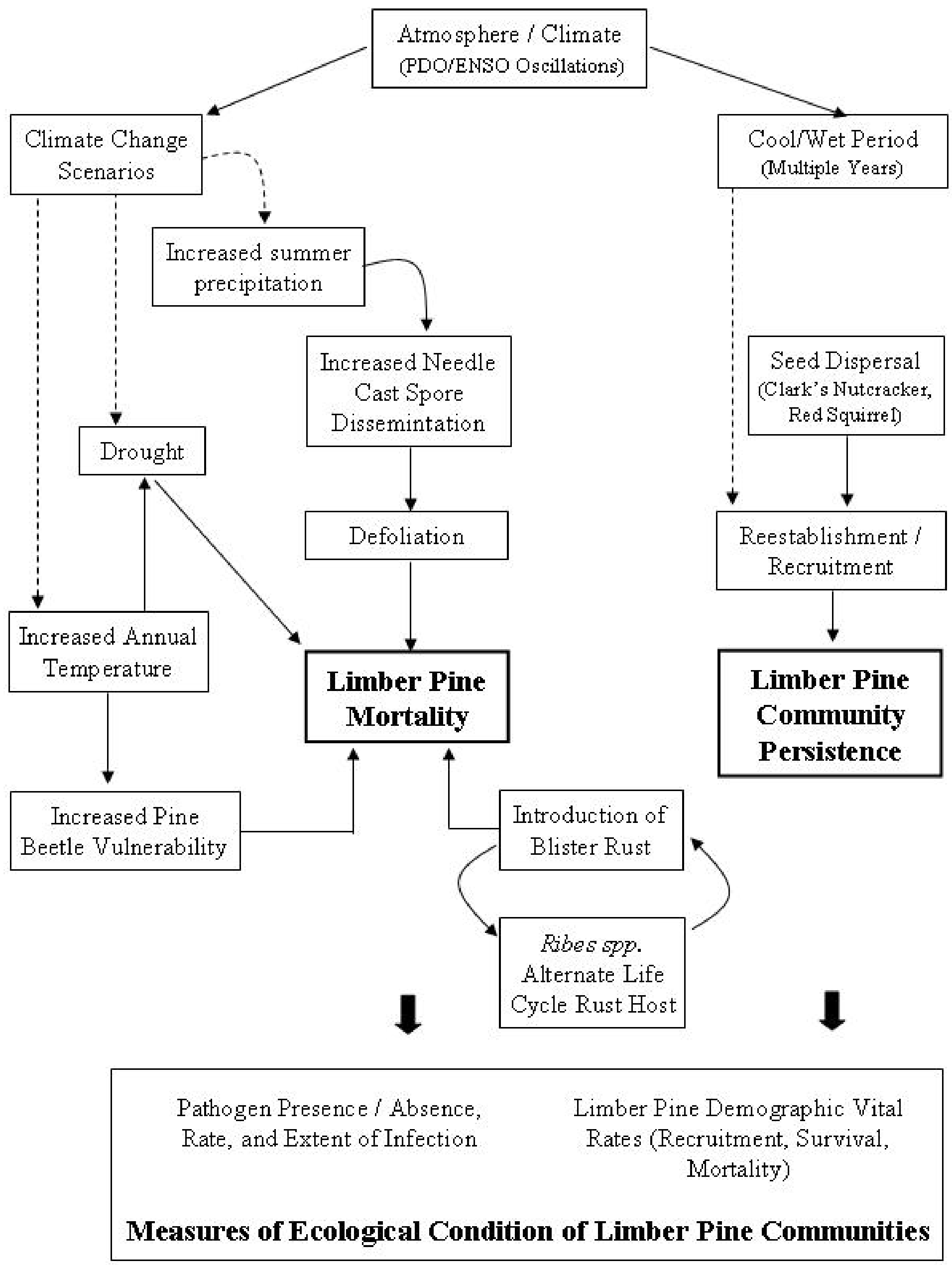
C. Aspen Community Dynamics Submodel

Figure C-10. Fire-driven aspen community dynamics. The dashed line represents a hypothesized or potential relationship.



D. Limber Pine Community Dynamics Submodel

Figure C-11. Insect and climate dependent limber pine community dynamics. Dashed lines indicated a hypothesized relationship.



E. Forest and Woodland Models Narrative

The distribution of forests and woodlands of the UCBN are largely governed by the topographic moisture gradient, as are their composition, structure, and function (Peet 2000). This gradient, in turn, has historically driven fire, insect pest outbreaks, and other disturbances. Anthropogenic stressors, including climate change and the introduction of exotic pathogens, have significantly altered forest ecosystem processes. Hessburg et al. (2000) reported significant declines in the interior Columbia Basin during the 20th century of old-growth structural characteristics, increases in shade-tolerant firs, as well as increasing fragmentation of remaining forests. They also reported that forest stands across the basin exhibited an overall condition of vulnerability to insect outbreak and catastrophic, stand replacing fires. These relationships are illustrated in figure C-9 and drive the community dynamics in figures C-10 and C-11.

Ponderosa pine forests are primarily found in LARO and represent the majority of the vegetation in the northern half of the recreation area. The area was heavily logged in the past and today very few stands exist that exhibit old-growth structural characteristics. Dendrochronology and fire scar studies from northeastern Washington indicate that ponderosa pine forests in the region exhibited “classic” high frequency, low severity fire regimes and that these forests consisted of large, mature trees with an understory of perennial grasses and forbs (Everett et al. 2000, Ohlson and Schellhaas unpublished). Much of this habitat has been converted through logging to young even-aged stands of “black bark” pine. Fire suppression has also dramatically altered the structure of these forests. Ohlson and Schellhaas report that in the Okanagan National Forest, northwest of LARO, ponderosa pine forests were almost twice as dense as historic conditions and that the western larch, a unique and important component to the forests of northeastern Washington, has declined significantly during the last 100 years. Forest management practices in LARO are currently focused on reducing stand density for fuel reduction. Potential stressor-induced effects stemming from LARO forest management include soil compaction and erosion, loss of snags and downed wood, and increased invasive weeds. A number of priority vital signs and monitoring objectives have been identified by the UCBN science advisory committee for future projects addressing the ponderosa pine ecosystem at LARO that focus on the effects resulting from altered forest structure and function and management response, including fire and fuel dynamics, invasive plants, forest structure, and insect pests.

The pinyon-juniper woodlands of CIRO, CRMO, and JODA are also disturbance-driven but pose difficult conceptual and management challenges for the UCBN because of the uncertain science surrounding the disturbance ecology of these communities (Soulé et al. 2004, Belsky 1996). Pinyon-juniper woodlands are a unique and important vegetation type that contributes to the biological diversity of the network but is also expanding into sagebrush-steppe, a phenomenon considered to be adversely affecting the ecological condition of steppe ecosystems (Gedney et al. 1999, Miller and Rose 1999). Fundamental differences exist in the structure and function of pinyon-juniper in each of the 3 UCBN parks. The western juniper woodlands at JODA have exhibited a dramatic shift in distribution during the 20th century, having expanded out of fire-protected draws and rims onto deeper soiled areas (Gedney et al. 1999, Miller and Rose 1999). Management at JODA is very concerned with this expansion and is actively pursuing control options through prescribed fire and selective cutting. However, the western juniper woodlands of eastern Oregon provide unique habitat value for frugivorous birds as well as unique mammals such as the pinyon mouse, and the historical benchmark of pre-expansion conditions are not adequately defined (Miller and Rose 1999, Baker and Shinneman 2004, Soulé et al. 2004). More importantly, the control of juniper, especially through use of prescribed fire, is problematic because it often leads to dramatic increases in noxious weeds (D'Antonio 2000, Bureau of Land Management 2002).

At CIRO, pinyon pine and rocky mountain and Utah junipers co-occur and represent a very unique habitat type for Idaho (Rust and Coulter 2000). Utah juniper reaches its most northerly distribution there and several Great Basin vertebrates, inclding the pinyon mouse, cliff chipmunk, and ringtail also are at the northern limits of their distribution there. While there may be some evidence for woodland expansion down into sagebrush flats at CIRO, it is much less of a concern than at JODA. At CRMO too, juniper expansion is of little or no ecological or management concern, as the type, dominated by rocky mountain juniper, occurs as scattered trees across the broken lava flows, and represents a relatively minor component of the overall landscape. Rust and Coulter (2000) suggest that some pinyon-juniper woodlands in southern Idaho may still be within historical ranges of variability for fire intervals, and this is probably the case at CIRO and CRMO. A much more pressing concern for the pinyon-juniper woodlands of southern Idaho parks in the UCBN is the new and emerging threat of *Ips confusus* bark beetle infection that was identified in approximately 30% of CIRO's pinyon pine stands in 2004. Monitoring of the *Ips* outbreak in CIRO is an anticipated future project, as is monitoring of the pinyon-juniper woodland associated vertebrates that reach their northern range limits in JODA and CIRO. Monitoring of juniper woodland dynamics in JODA will be addressed within the sagebrush-steppe vegetation monitoring effort.

Aspen groves occur in isolated stands in CIRO, CRMO, BIHO, and LARO. These woodlands provide important habitat values and support cavity nesting birds and other vertebrates that would not remain in the parks in the absence of aspen (Lawler and Edwards 2002, Griffis-Kyle and Beier 2003, Parsons et al. 2003). Aspen is a particularly important resource for cavity nesting birds and bats because of the structural characteristics that form in mature stands (Parsons et al. 2003). Marked declines in aspen have been noted throughout the intermountain west and been the subject of much debate (Peet 2000). Fire suppression has been identified as the most widespread proximal factor, but elk browsing and domestic cattle grazing has also been recognized (Rogers 2002, Larsen and Ripple 2003). Figure C-10 illustrates the relationship between reduced fire, browsing, and grazing on declining rates of regeneration in aspen stands. Like many of the systems in the UCBN, the actual relationships have not been investigated for aspen stands in the UCBN, but preliminary investigations are planned for CIRO and CRMO and long-term monitoring of aspen vegetation and associated vertebrate communities has been recognized as a priority network activity.

Limber pine occurs on Graham Peak in CIRO but is most significant at CRMO, where it occurs in many, isolated small stands in the northern portion of CRMO. This species is considered a relict by some investigators but this is not entirely clear (Schuster et al. 1995). Limber pine forms rather monotypic stands along the rocky exposed soils on north facing slopes of cinder cones and other volcanic features in CRMO. The patchy distribution of limber pine reflects its physiological requirements and its dependence on Clark's nutcrackers, red squirrels, and other vertebrates for seed dispersal (Figure C-11; Schuster et al. 1995). Limber pine stands in CRMO represent a unique and important component of biodiversity in the network. The primary threats to limber pine include those from insect and disease pathogens and climate change (Long 2003). Limber pine ecosystems in CRMO are probably not adversely affected by fire suppression, harvest, or other management-type stressors. White-pine blister rust and needle-cast are the two pathogenic threats that have caused considerable mortality among populations of 5-needle pines in general, and specifically in limber pine populations in Montana and Colorado (Jackson and Lockman 2003). To date, outbreaks have not occurred in CRMO limber pine stands, but may do so in the future. Global warming has been identified as a potential cause of increased outbreaks in the future (Logan and Powell 2001). Monitoring is planned for limber pine in CRMO.

C-4. Riparian Ecosystems

A. Introduction

Riparian zones are the transition areas between terrestrial and aquatic ecosystems and can be difficult to delineate because of high complexity and heterogeneity in form and function (Gregory et al. 1991, Naiman and Decamps 1997). They are often defined by the presence of hydrophilic vegetation and soils which are strongly dependent on adjacent surface or groundwater (i.e., Cowardin et al. 1979). Gregory et al. (1991) provide a more integrated conceptual framework for considering riparian zones as a union of complex geomorphic and biotic components and processes (Figure C-12). Functionally, riparian zones interact with adjacent terrestrial and aquatic systems in three dimensions; longitudinally along borders of aquatic areas, laterally away from aquatic areas into adjacent uplands, and vertically through the canopy of riparian vegetation (Gregory et al. 1991). In the arid west, riparian systems typically occur in narrow bands and gradients between aquatic, riparian, and upland systems can be quite steep.

Riparian areas are highly productive compared to upland areas (e.g. Kauffman et al. 2004), contain unique floral and faunal communities, act as seasonal migration corridors or refuges (Shirely 2004), and consequently increase regional biodiversity (Wright et al. 2003). While riparian areas may only represent a small proportion of total land area, they have disproportionate influences on biological communities and ecosystem processes. For example, wetland and riparian areas comprise less than 2% of three western states (Wyoming, Nevada, and Montana), but more than 80% of the wildlife in those states use these habitats during some portion of their life cycles (McKinstry et al. 2004). Additionally, riparian ecosystems provide essential ecosystem services, including nutrient cycling, water purification, stream bank stability, and attenuation of floods (Kauffman et al. 1997, Wissmar 2004, Sweeney et al. 2004).

Significant alteration and degradation of interior Columbia Basin riparian ecosystems have occurred over the last 150 years (USDA Forest Service 1996, Kauffman et al. 1997). Historic land use practices, including ranching and farming, have had long-term impacts on riparian hydrologic, geomorphic, and biotic structure and function. Figure C-13 illustrates the inextricable linkages between biota, geomorphology (including soils), and hydrology upon which riparian ecological condition depends. Anthropogenic stressors have led to interruptions between these links and triggered cascading ecosystem effects in terrestrial and aquatic systems as well as within riparian zones. The following conceptual models focus on the ecosystem dynamics that influence riparian vegetation structure and function. A submodel for bat communities has been included here because of their strong dependence on riparian and aquatic habitats. Both riparian vegetation and the bat community have been identified as important vital signs for the UCBN monitoring program.

Figure C-12. Representation of relationships between geomorphic, biotic, and aquatic ecological components (rectangles) and processes (circles) in riparian ecosystems (from Gregory et al. 1991).

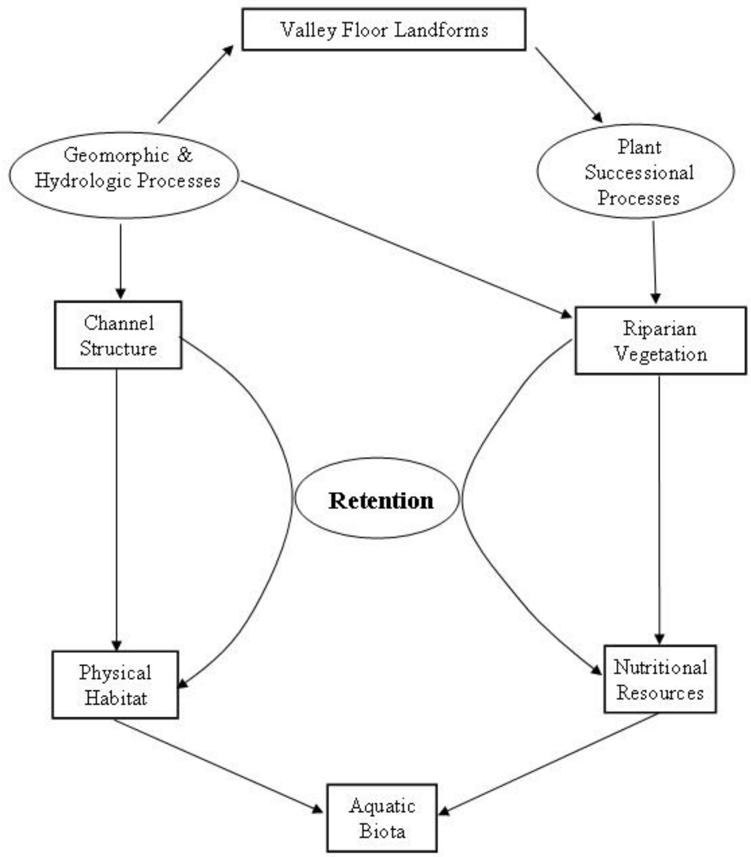
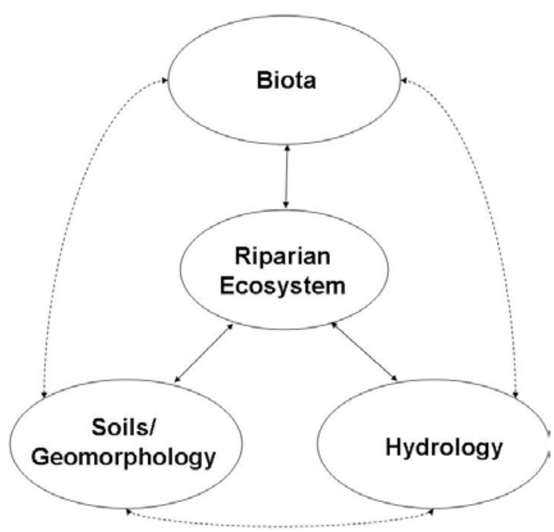
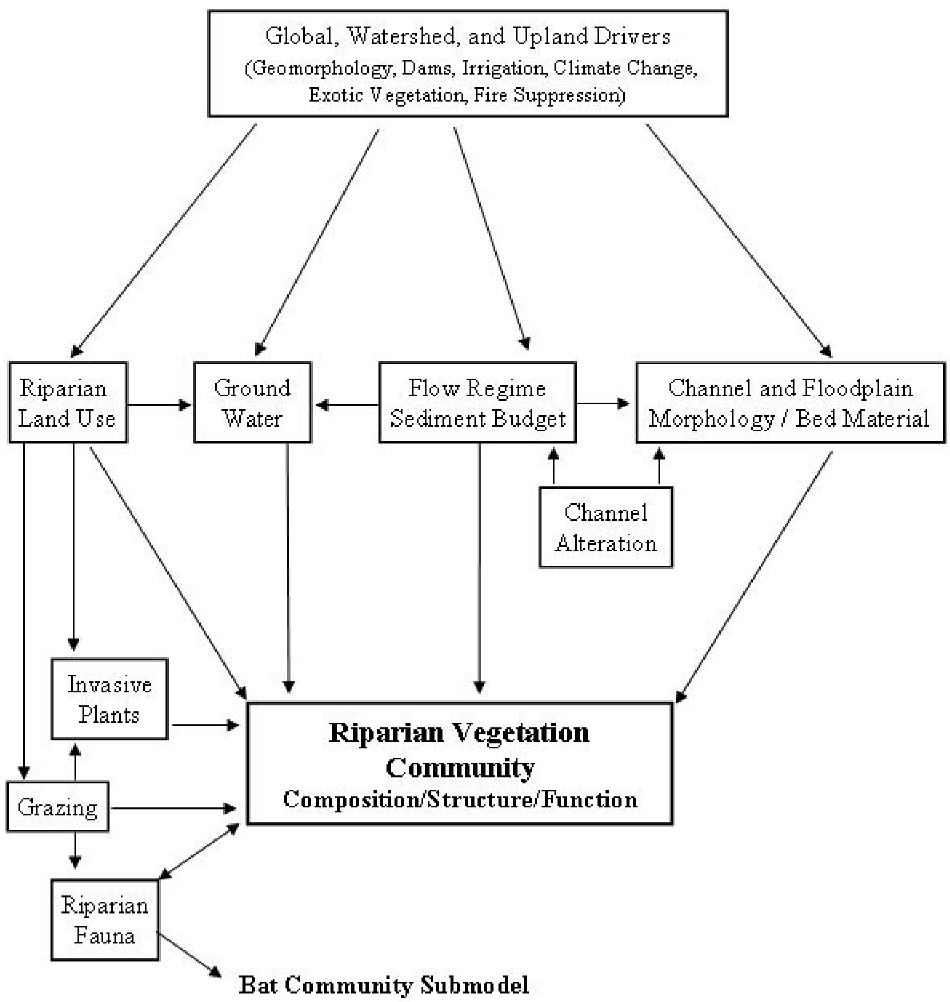


Figure C-13. The structure and function of riparian ecosystems are driven by biotic, hydrologic, and geomorphic components and processes (from Kauffman et al. 1997).



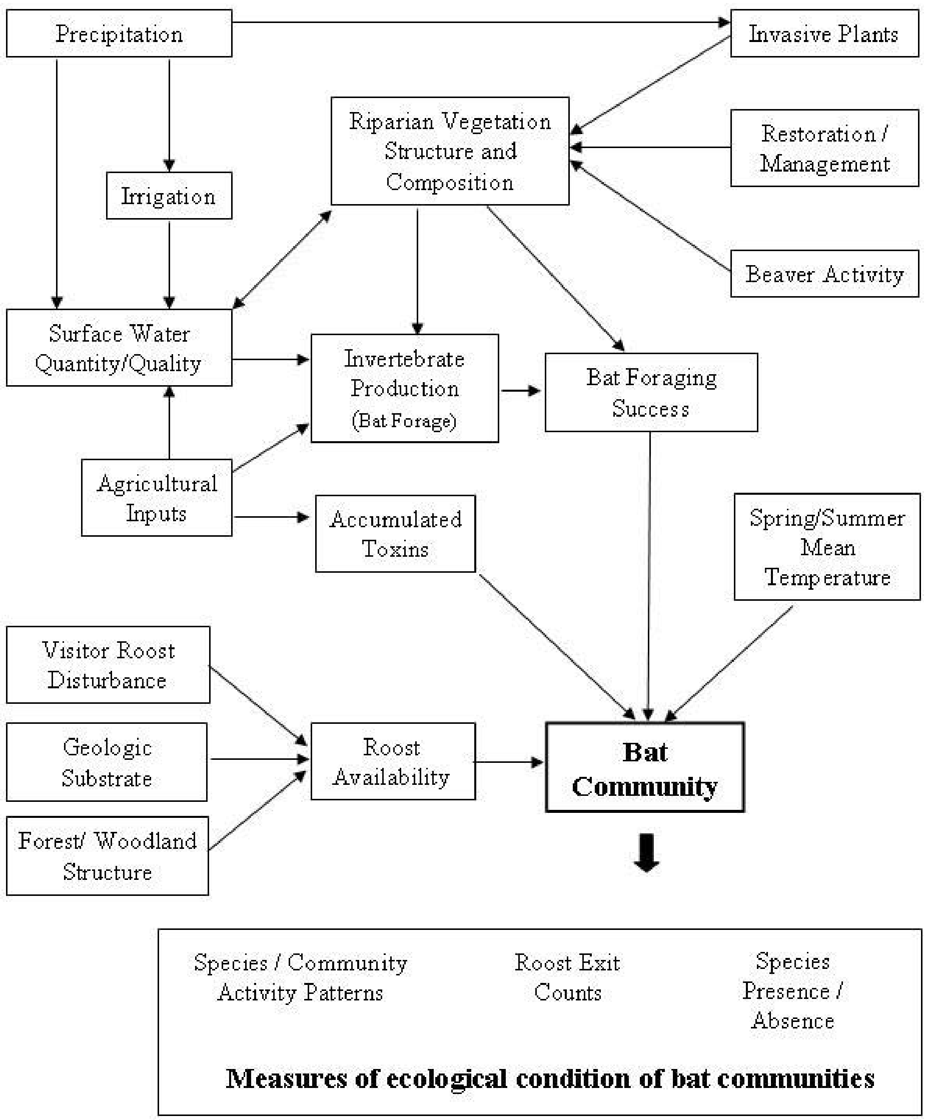
B. Riparian Ecosystem Control Model

Figure C-14. Hydrologic, geomorphic, and biotic drivers and stressors of riparian vegetation communities in the UCBN.



C. Bat Community Dynamics Submodel

Figure C-15. Relationship among riparian vegetation, invertebrates, and bats. Roost dynamics are represented here, underscoring the important lateral connection between riparian and aquatic and upland systems.



D. Riparian Ecosystem Models Narrative

Riparian ecosystem processes are strongly linked to global and watershed drivers that also affect river processes because both are strongly dependent on prevailing hydrologic and sediment regimes (Figure C-14; Naiman and Decamps 1997, Wissmar 2004). A central driver in both riparian and lotic systems is the flow regime (Poff et al. 1997), which is a description of the timing, magnitude, and variability of streamflow. In the UCBN, changes in channel morphology and most erosion occur during spring run-off. Notably, spring run-off follows a highly predictable seasonal pattern, but differs markedly among years in timing and magnitude, and it is this variation in magnitude that is a primary influence in determining the disturbance regime in both habitats. In semi-arid regions such as the UCBN, the flow regime tends to be less predictable and results in streams with "flashy" flow patterns. Collectively, the flow regime and upland drivers have strong effects on riparian sediment dynamics by determining sediment input rates and erosive potential.

Fluvial geomorphology also has strong effects on riparian communities. In high gradient reaches, constrained channels limit the width of the riparian zone and higher erosion results in lower soil organic matter, whereas lower gradient reaches are typically less constrained, have higher channel sinuousity, lower stream power and erosion, and finer soils with higher soil organic content (Naiman and Bilby 1998). Flow regime and channel morphology directly affect soil conditions, local disturbance regime and riparian vegetation. Flow regime and sediment budget interact with watershed drivers to determine ground water levels, and these have strong effects on riparian vegetation. Riparian vegetation, in turn, influences ground water conditions through evapo-transpiration (Naiman and Bilby 1998). Riparian vegetation has strong effects on channel form because vegetated riparian areas resist erosion and provide structural and nutrient inputs from woody debris and other dead material, or necromass (Kauffman et al. 1997, Gregory et al. 2003). Riparian vegetation is also controlled by soil characteristics, disturbance (flood) regime, directly by native and non-native grazers (beavers, elk, and livestock; Naiman et al. 1988; Baker et al. 2005), and indirectly by their predators (Beschta 2005).

Because of the importance of water to human societies and scarcity of water in the west, in general, and in the UCBN in particular, riparian and wetland areas have been drastically altered by current and historical human activities (McKinstry et al. 2004, Wissmar 2004). Over the past two centuries a large number of human activities have impacted riparian areas of the UCBN including mining, livestock grazing, fire suppression, timber harvest, agricultural practices (including irrigation), recreation, dams, construction of flood control and transportation infrastructure, urbanization and suburbanization, and the transport of exotic flora and fauna (reviewed in Dwire and Kaufmann 2003, Wissmar 2004). The greatest change in the Columbia Basin has occurred since the economic development associated with World War II (USDA Forest Service 1996). During this period, there have been large scale changes in upland land-use and the regulation of the region's water resources. There are currently more than 400 dams in the Basin. Riparian habitats in UCBN park units are no exception to the regional pattern, and alterations include channelization and confinement (WHMI, BIHO, HAFO), alteration of hydrologic regime through damming (Snake & Columbia Rivers: NEPE, HAFO, LARO; stock ponds, JODA), irrigation (HAFO), and diversion (WHMI), presence of introduced species (bullfrogs, most UCBN units), and grazing (Weippe Prairie NEPE, CIRO, LARO).

These changes in global and watershed drivers have strong effects on riparian biota, primarily thorough alteration of physical habitat and flow regimes. Dams and irrigation alter channel and floodplains directly by changing surface and ground water levels, and indirectly by altering flow and sediment regimes (Montgomery and Buffington 1998). In particular, flow regulation prevents large flow events (floods) that have the greatest effect on floodplain form and sediment composition (Benda et al. 1998), and plant succession (Naiman et al. 1998). Local irrigation and conversion to agriculture or pasture in flood plain areas often includes portions of the riparian zone. Global and watershed drivers, especially urbanization, may directly affect channel and floodplain morphology through channelization and flood control projects.

Both figures C-14 and C-15 illustrate the influence of invasive plants on riparian vegetation. In the UCBN, riparian zones are heavily infested with non-native vegetation. In many riparian areas, the vegetation consists entirely of non-native species. The productivity of these sites contributes to this, but the intensity of historic damaging land use practices in riparian areas, including grazing and irrigation developments, is a primary factor. Wholesale shifts in riparian vegetation composition and structure have occurred in the UCBN, with native plant communities replaced by monocultures of reed canary grass, knapweeds, and other exotic species. Native riparian cottonwood galleries have been eliminated and replaced with non-native herbaceous vegetation, resulting in significant structural changes as well as in species composition.

The effects of these changes in vegetation structure and composition on riparian-dependent vertebrates has been well articulated for birds, but not as well for other taxa, including bats (e.g. Knopf and Samson 1994, Dobkin et al. 1998). For example, riparian structure and composition has been linked to population viability of the southwestern willow flycatcher and avian richness has been positively correlated with structural conditions in riparian zones (Dobkin et al. 1998, Sogge and Marshall 2000). Bats are also strongly associated with riparian and aquatic environments, which they use nightly for drinking and foraging, and bats may be effective indicators of riparian vegetation condition (Figure C-15; Fenton 2003). For example, bats respond to structural conditions and seek out optimal foraging areas (Mackey and Barclay 1989, Brigham et al. 1992). Likewise, insectivorous North American bats include both invertebrate prey generalists and specialists, and they respond to availability of prey by shifting foraging in space and in diet composition (Whitaker et al. 1981, Brigham et al. 1992, Whitaker 2004). Figure C-15 illustrates how vegetation structure and composition influences both prey availability and foraging success. Bats exhibit high fidelity to roosting and foraging areas but will quickly alter use patterns in response to changes in resource conditions (Fenton 2003, Rodhouse and Wright, 2004, Vielleux and Vielleux 2004). Hickey et al. (2001) have also demonstrated that bats are vulnerable to accumulations of agricultural chemicals. In the UCBN, as many as 14 species of bats can occur together, representing up to seven state and federal species of concern, including the rare spotted bat (Rodhouse et al. 2005). Several diets and foraging strategies are represented, including beetle and moth specialists (Coleoptera and Lepidoptera, respectively), as well as generalists that respond to hatches of aquatic flies (Trichoptera and Diptera) (Whitaker et al. 1981, Verts and Carraway 1998). This sensitivity to insect abundance and foraging habitat structure, as well as their mobility and longevity, warrants inclusion of bats as indicators of riparian ecological condition in the UCBN (Fenton 1993).

Although not directly related to riparian ecosystems, roost availability is represented in figure C-15 also as a significant issue for at least some species of bats found in the UCBN, and further illustrates the lateral connectivity between riparian systems with aquatic and upland systems. Species such as the pallid bat and Townsend’s big-eared bat select roosts in geologic features that are limited in availability across the landscape in the UCBN (Lewis 1995, Keller 1997, Rodhouse and Wright 2004). These same species are also vulnerable to human disturbance at roosts (O’Shea and Vaughan 1999). Foliage and tree-roosting bats, including the hoary bat and silver-haired bat, may also be roost limited in the UCBN because of the historic reductions in cottonwood galleries and aspen groves, and landscape-level reductions in snags in ponderosa pine forests of LARO (Pierson 1998).

C-5. Aquatic Ecosystems

A. Introduction

Aquatic ecosystems are typically subdivided into lotic (running water) and lentic (lake and pond) habitats although impoundments on some of the larger river systems have also created lentic conditions. Though small in terms of surface area, they have a disproportionate impact on biological communities, ecosystem processes, and regional biodiversity. Riparian habitats are the ecotone, or border, between upland and aquatic habitats. Wetlands are areas with saturated soil or shallow (<1m) surface water, and frequently with extensive areas of floating or emergent vegetation. Despite these intuitive definitions, the classification of aquatic habitats is often problematic because of the diversity of habitat types within ecosystems, temporal variation within habitats (e.g., water level), and the often indistinct transition between habitat types (e.g., riparian vs. upland forest; when does a pond become a lake?). This is particularly true of riparian and wetland areas (McKinstry et al. 2004).

The ecology of freshwater is strongly affected by drivers and stressors at multiple scales, and these drivers are hierarchical or nested (Poff et al. 1997, Allan 2004; Figure C-16). The largest scale drivers are global or regional drivers acting on entire watersheds such as precipitation, climate regime (e.g., PDO, ENSO, Beebee and Manga 2004), underlying geology and topography, and large scale disturbances including volcanic (e.g. Quinn et al. 1991) and large-scale fires (Rieman et al. 2003). Global and landscape stressors include human-induced climate change, non-local pollution sources (e.g. atmospheric nitrogen deposition), alterations to hydrologic regimes through damming and irrigation withdrawals, and broad scale cultural policies affecting water quality and fisheries policy (National Research Council 1996, Rahel 1997, Poff et al. 2003, Postel and Richter 2003).

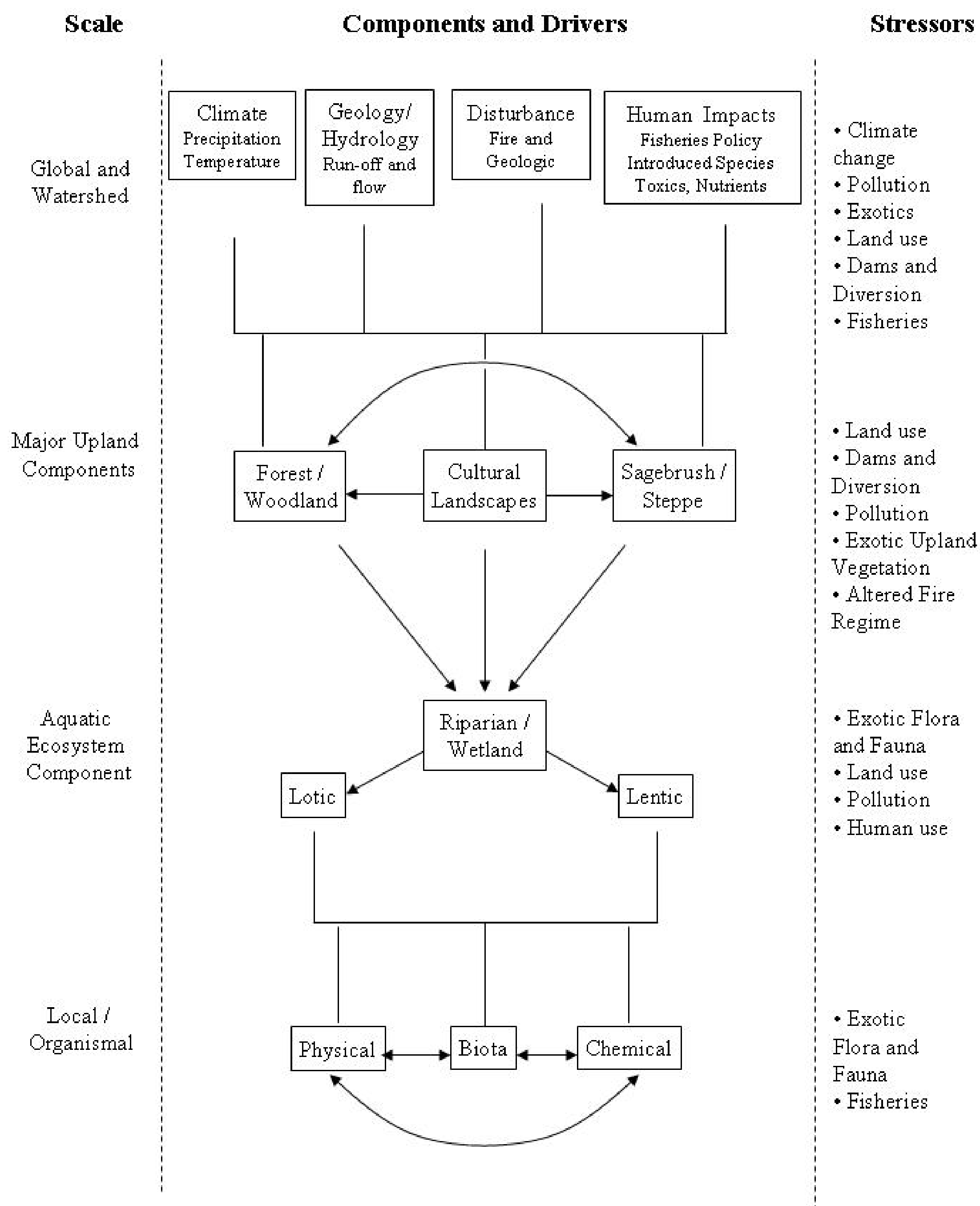
Within individual drainage basins, upland land-cover/land-use and cultural landscapes strongly affect aquatic ecosystems and communities by influencing hydrology, physical habitat, and nutrient, sediment, and toxicant inputs (Thompson and Lee 2000, Kershner and Roper 2004, Allan 2004). Many of the effects of upland habitats are mediated (and ‘buffered’) by riparian areas and wetlands because these areas strongly affect the magnitude and timing of upland inputs to surface water habitats (Naiman and Bilby 1998, McKinstry et al. 2004). For instance, riparian condition strongly affects aquatic physical habitat characteristics including light availability, temperature, channel form, sediment regimes, and substrate composition (Naiman and Bilby 1998, McKinstry et al. 2004).

The local distribution and abundance of aquatic organisms within each habitat type are determined primarily by spatial heterogeneity in physical and chemical properties among microhabitats (current speed, temperature, nutrients, dissolved oxygen; Allan 1995, Dodson 2005), while global and watershed drivers indirectly affect local communities by determining the characteristics of physical habitats and influencing regional species pools. In turn, biota can alter the physical and chemical environment through metabolic activities (nutrient uptake, excretion, respiration), redd-building behaviors by salmonids that alter sediment composition and transport (Gottesfeld 2004), and the “ecosystem engineering” activities of beaver damming (Jones et al. 1997), or even stream macroinvertebrates (Zanatell and Peckarsky 1996). Introduced species and manipulation of fish populations represent stressors acting at the local scale. Predator-prey and competitive interactions with introduced species, including warm water fishes, bullfrogs and non-native salmonids, have strong local effects on communities (Levin et al. 2002, Kolar and Lodge 2002, Adams et al. 2003). For instance, survival of Chinook salmon juveniles in wilderness streams without introduced brook trout was near twice that of salmon in invaded streams (Levin et al. 2002).

Interestingly, most aquatic systems are characterized by "open populations" where immigration and emigration have strong effects on local population dynamics (Schlosser 1995, Peckarsky et al. 2000, Bilton et al. 2001, Fausch et al. 2002, Caudill 2003), and consequently, the condition of upland and riparian migration corridors can have strong effects on local population dynamics of aquatic species with terrestrial life history stages (e.g., aquatic insects, amphibians). Consequently a major challenge to effectively managing and conserving aquatic populations is that local management efforts may be swamped by regional scale population and ecosystem processes. The following models and narrative emphasize the "open" and three-dimensional nature (discussed for riparian ecosystems above) of aquatic ecosystems. Influences from upland and riparian inputs and watershed-scale drivers are emphasized

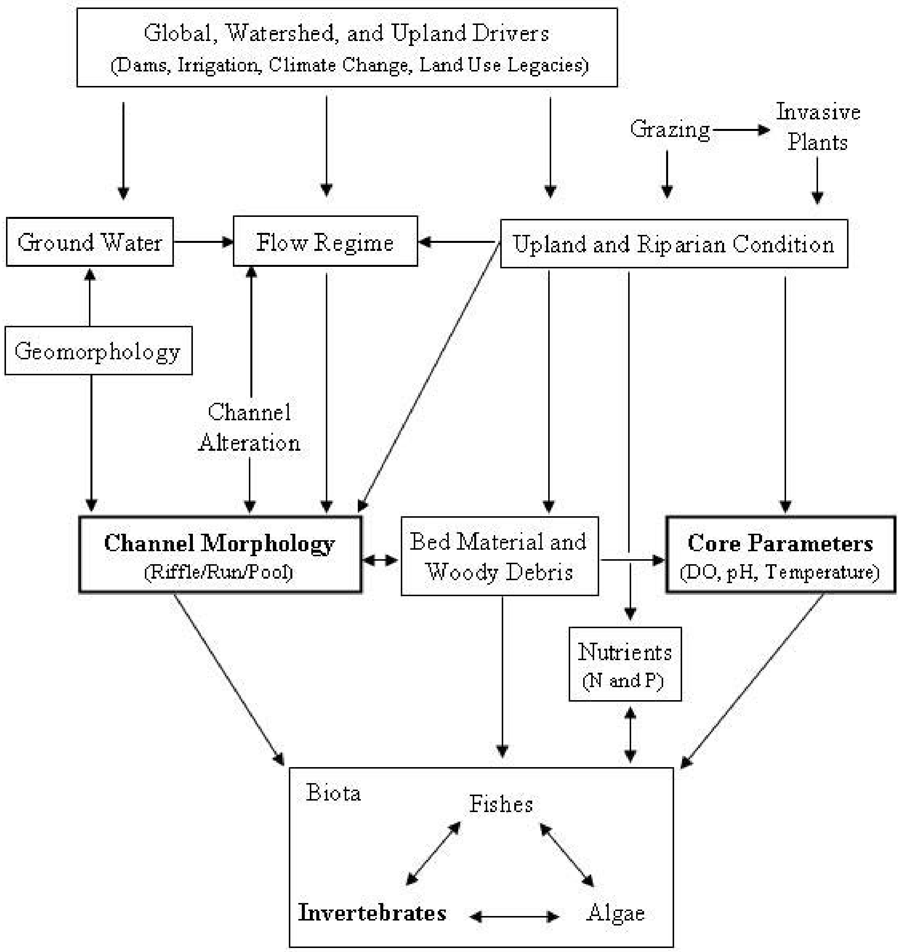
B. Aquatic Ecosystem Control Model

Figure C-16. Fundamental components and processes of aquatic ecosystems at multiple nested scales.



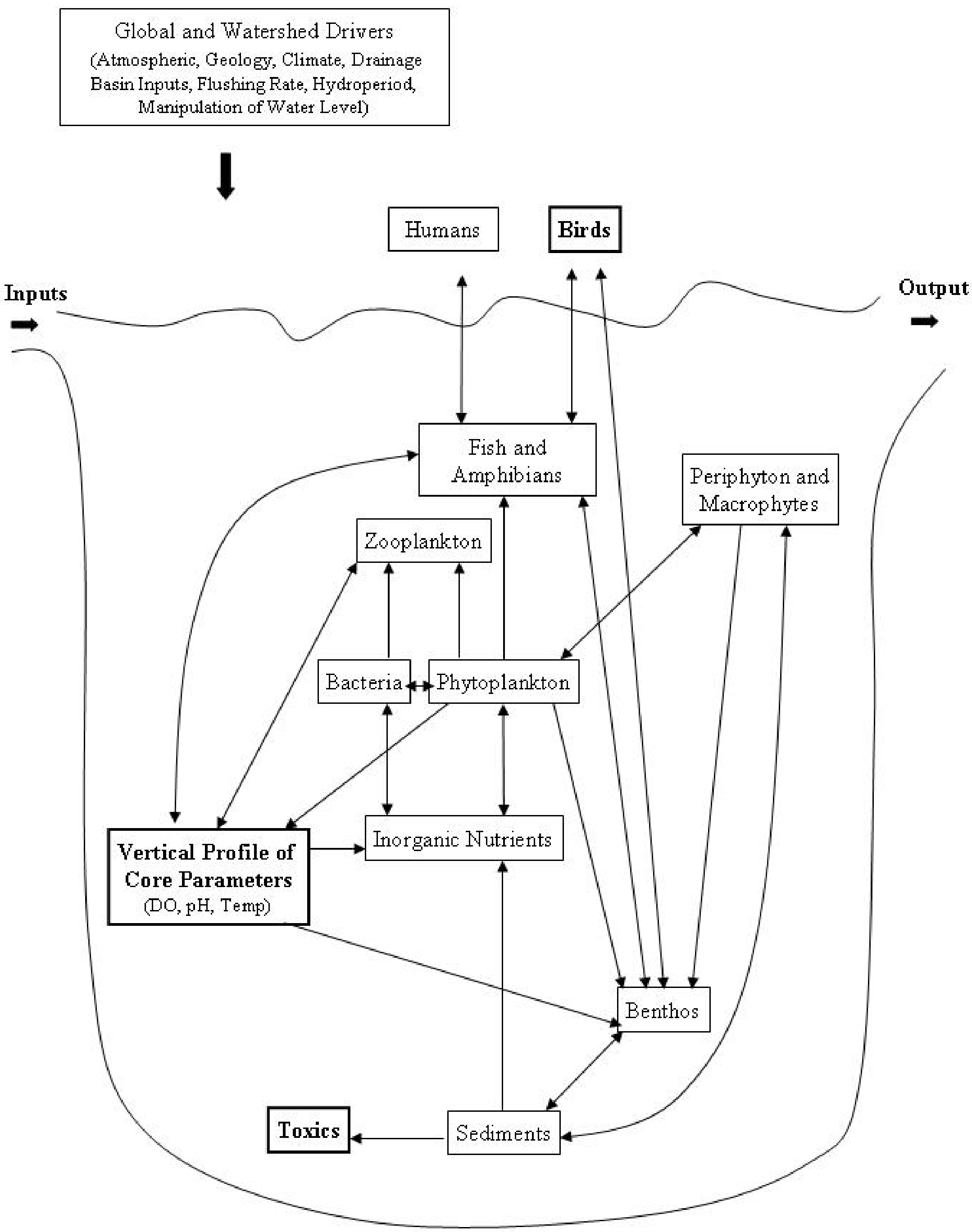
C. Lotic Ecosystem Submodel

Figure C-17. Hydrologic, biotic, and geomorphic components and processes of UCBN lotic systems.



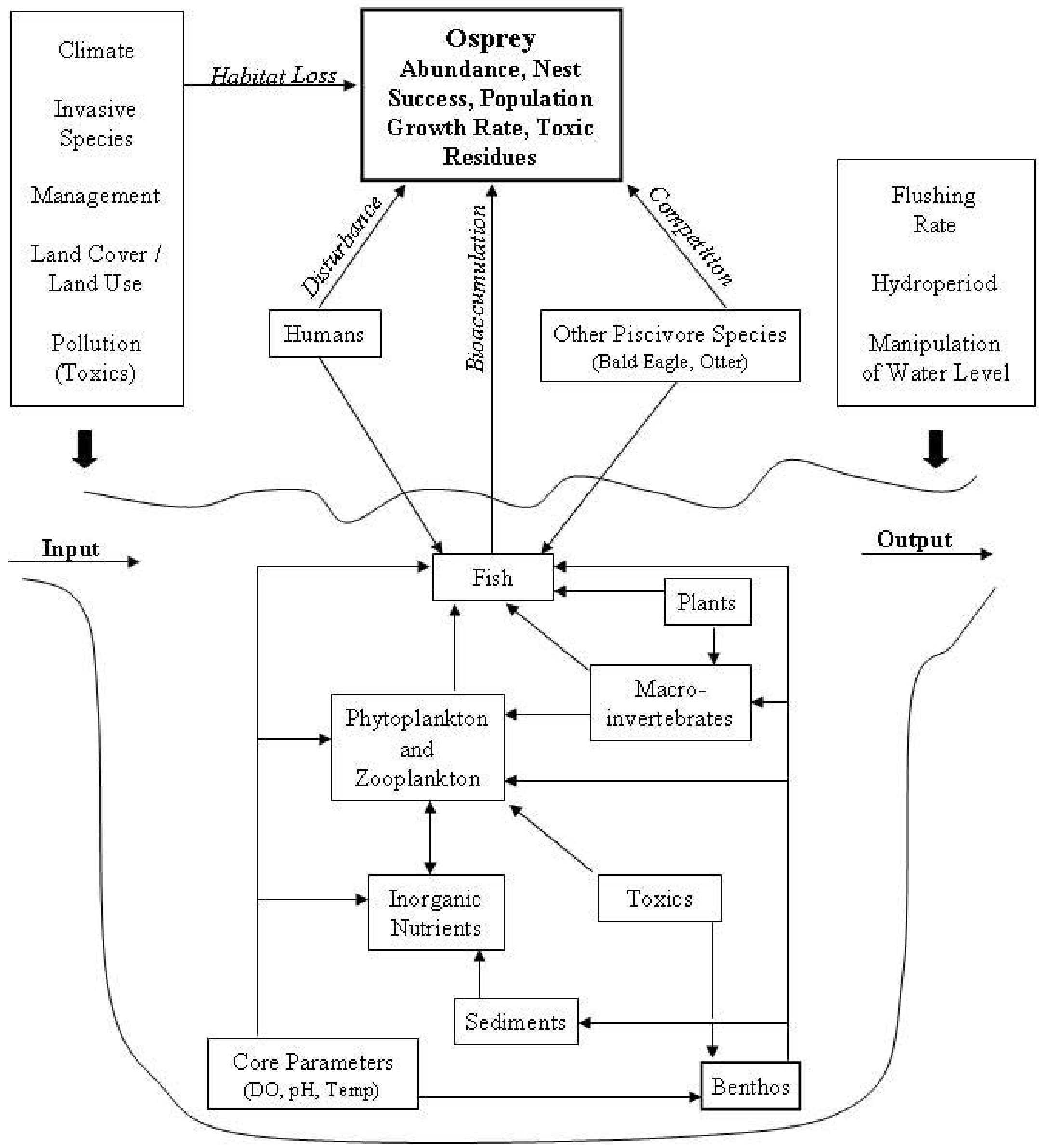
D. Lentic Ecosystem Submodel

Figure C-18. Hydrologic, biotic, and geomorphic components and processes of UCBN lentic systems.



E. Osprey Population Stressors Submodel

Figure C-19. External and internal sources of osprey population stress in Lake Roosevelt National Recreation Area (lentic system).



F. Aquatic Ecosystem Models Narrative

Lotic Ecosystems: Streams and Rivers

Figures C-16 through C-19 all emphasize global and watershed processes and geomorphology, which are frequently modified by riparian and groundwater processes, and have strong effects on unmodified streams and rivers by determining local stream gradient, sediment and nutrient inputs, water chemistry, thermal regime, and ground water budgets (Allan 1995, 2004; Naiman and Bilby 1998, Matheussen et al. 2000). The flow regime, in conjunction with these larger scale drivers, determines the structure and distribution of meso- and microhabitats within the stream channel. The relative distribution of channel units (typically riffles, runs, and pools) is strongly affected by geomorphology, flow regime, upland and riparian condition, bed material and wood. In steep streams with constrained channels, riffles and runs may dominate, while in similar streams with wider floodplains, classic riffle-run-pool sequences may develop (Allan 1995). The distribution of wood interacts with channel units because wood can accumulate in pool habitats, and because large wood has strong effects on local channel morphology, frequently creating dams, undercuts, and pools (Gregory et al. 2003). Upland land cover (e.g., forest vs. shrub-steppe) and flood frequency and magnitude regulate the build-up and distribution of wood in stream channels. Gradient, local geology, flood frequency and magnitude, and soil affect the particle size distributions in channels by determining the erosive power of a stream. These drivers also act on substrate characteristics through their effects on upland and riparian condition, with larger cobbles and gravels common in mountainous high gradient streams and sands and silts dominating in lower gradient streams.

Locally, the abundance and distribution of stream biota are controlled by these meso- and microscale habitats, biotic interactions, and by small scale heterogeneity in water chemistry. For example, many stream invertebrates are restricted to riffles and fish assemblages in slow water and rapid water channel units often differ. Water chemistry can have both local and regional effects on biota. In particular, pH, temperature, nutrient concentrations, and dissolved oxygen have strong effects on stream biota. Regionally, climate and geology affect broad-scale patterns of stream thermal regime, pH, and nutrient status, which collectively have strong influence on the regional species pool and patterns of community structure (Allan 2004). Nutrient concentrations are determined by complex interactions between inputs and transformations within the stream, primarily by algae and microbes, and may limit primary productivity in some systems. The local distribution of organisms may be affected by smaller scale heterogeneity in water chemistry patterns as well. For instance, stream reaches with cool water were important refuges for summer Chinook salmon on the John Day River (Torgersen et al 1999). Finally, biotic interactions including both negative (competition, predator-prey, parasitism; Allan 1995) and positive interactions (facilitation and mutualisms; Hay et al. 2004).

Not surprisingly, stream communities are affected by stressors at multiple scales, and again many of these are shared by riparian habitats. Generally, stressors work through three general pathways: stressors affecting physical habitat characteristics, landscape alterations that include changes to stream nutrient status, and alteration of biotic interactions by the introduction of non-native species, including game fishes. Changing climate affects lotic habitats directly by altering precipitation patterns and thermal regimes, and indirectly through the alteration of upland and riparian communities. The regulation of rivers by damming clearly has strong effects on the communities of inundated reaches, but also strong effects on downstream communities through the alteration of sediment budgets, flow, thermal, and disturbance regimes; irrigation withdrawal produces similar effects (Poff et al. 1997, Postel and Richter 2003). Attenuation of peak flows can impact stream biota because important life history events are cued by annual high flow events in many species (Lytle and Poff 2004).

Land use legacies alter thermal and flow regimes primarily by altering vegetative land cover from the historical condition (Matheussen et al. 2000). For example, differences in mean stream temperature among sub-basins of the John Day River were attributed to differences in land use (Torgersen et al. 1999). In general, alterations in land cover affect stream biota, and the magnitude of the impact depends both on the type, extent, and spatial arrangement of altered land use classes (Allan 2004). In addition to contemporary land use patterns, historical land-use legacies, including grazing, logging, and agriculture can have long lasting effects that affect hydrology and biotic communities (Harding et al. 1998, Matheussen et al. 2000).

Exotic species have strong impacts on aquatic ecosystems, and important intentionally or accidentally introduced species in the Columbia Basin include largemouth and smallmouth bass, walleye, American shad (*Alosa sapidissima*), brook trout, and brown trout. These species affect food web dynamics (Baldwin et al. 2003, Naughton et al. 2005) and interact with native fishes (Levin et al. 2002). Other important invaders include the New Zealand mudsnail (Hall et al. 2003, Richards et al. 2004) and non-native macrophytes. Alteration of the flow regime, particularly the attenuation of peak flows, may facilitate the invasion of non-native species in flood-dominated regions with flood adapted native fauna.

Beaver (*Castor canadensis*) and anadramous fish are two keystones that have strong current and historical effects on freshwater ecosystems in the Columbia River Basin. Beaver have strong direct effects on vegetation through tree cutting and browsing activities (Naiman et al. 1988) and larger effects through dam building activities (Naiman et al. 1988, Pollock et al. 1995, 2003). Beavers are the quintessential ecosystem engineer (Jones et al. 1997) because pond construction drastically alters riparian and stream physical habitat and biota. Historically, beavers and beaver ponds were the dominant feature of permanent streams throughout North America, including the UCBN, and the majority of headwater stream were likely dammed (Pollock et al. 2003, Laliberte and Ripple 2003). Reported pond densities from relatively undisturbed populations range from 9.6 to as high as 73.7 dams / km along Rocky Mountain streams with slopes of 1-12.5% (reviewed in Pollock et al. 2003). In the well-drained intermountain west, beaver ponds probably were, and currently may be, the most common wetland type numerically and by total area. Moreover, available literature suggests these ponds have strong and generally positive effects on habitat and biota. Damming increases hydraulic recharge of aquifers, in some cases shifting ephemeral streams into perennial streams supporting salmonid populations (Pollock et al. 2003). The depositional environment alters sediment dynamics, widens floodplains and riparian areas, and increases nutrient retention and processing (Naiman et al. 1986, 1994, reviews in Naiman et al. 1988, Pollock et al. 1995, 2003). Increased productivity per stream length and increased habitat heterogeneity increase regional plant (Wright et al. 2002) and bird (Medin and Clary 1990, Brown et al. 1996) diversity in riparian areas. More recently, the indirect effects of marine-derived nutrients transported by salmon on stream, lake, riparian, and even upland, communities has been recognized (Helfield and Naiman 2001, Koyama et al. 2005, Wilkinson et al. 2005, Quinn 2005).

Lentic Systems: Lakes and Ponds

Standing water habitats encompass a wide range of sizes and types, from small temporary wetlands to ponds to large lakes. Like other aquatic habitats, they are affected by drivers and stressors at multiple scales (Figures C-18 and C-19). Global drivers include climate, basin morphometry, precipitation rates, and nutrient inputs determined by both water- and air-shed inputs. Local drivers include point sources of nutrients, local bathymetry, local water chemistry, and local bottom type. Major stressors include alteration of nutrient status and water chemistry through cultural eutrophication, increased sedimentation, and acid rain, alteration of shorelines and littoral zones through development, inputs of toxics, fishing and boating impacts, and the introduction of non-native species. Reservoirs, by definition, result from a stressor (dam) applied to a stream or river, and differ from ponds and lakes in important respects.

The character of a particular lake is strongly influenced by its hydroperiod (i.e., whether it dries), morphometry, water source, and nutrient status. Typically, permanent ponds and lakes with sufficient depth have well developed fish communities. Temporary ponds and shallow ponds that periodically dry or “winter-kill” have vertebrate communities dominated by amphibians and distinct invertebrate communities (Wellborn et al. 1996). Overall size and depth influence both the relative ecosystem importance of benthic (bottom associated) versus pelagic processes and whether the water column stratifies or not. The magnitude and relative contribution of different water sources (precipitation, riverine or groundwater) affect water level fluctuations, flushing rate, and nutrient inputs. Finally, one of the strongest controls on biological communities in lentic habitats is nutrient status—whether the body is oligotrophic, mesotrophic, or eutrophic—because phosphorus and nitrogen frequently limit primary production (Barber et al. 1999, Dodson 2005).

The largest lentic ecosystem in the UCBN is Lake Roosevelt, a meso- to oligotrophic reservoir on the Columbia River behind Grand Coulee Dam that spans approximately 210 river kilometers (Barber et al. 1999) and displays lotic conditions in the upper portion. Lentic habitats at all other units are substantially smaller and comprised primarily of oxbow lakes or small artificial ponds. Oxbow lakes are present in BIHO and NEPE, formed by the Big Hole and Snake Rivers, respectively. JODA has two stock ponds in the Clarno Unit, Schwartz Pond is an old mill pond in NEPE, and WHMI also has a restored millpond. CRMO has perhaps the greatest diversity in lentic habitat types, with many small vernal pools and ponds associated with lava tubes, and part of the unit borders the approximately 15 acre Lava Lake. Small temporary habitats, such as those at CRMO, remain largely uninvestigated but probably have similar ecologies to the temporary ponds known as Tinajas formed in sandstone depressions in southeastern Utah (Anderson et al. 1999).

Under natural conditions, several global and watershed drivers have strong influence on lentic habitat structure and ecosystem process. Water chemistry is strongly affected by the geology and land cover within the drainage basin, and by precipitation and atmospheric inputs. Drainage basin geology and climate also affect morphometry by determining depth, size, shoreline development (shoreline length / area), flushing rate and seasonal and annual water levels. In particular, depth has a strong influence on stratification. Riverine and groundwater inputs of nutrients eventually equilibrate with outputs under natural conditions. Inputs of sediment eventually fill lake basins over geologic time scales.

There are predictable seasonal changes in water chemistry in temperate lakes. Most lentic habitats exhibit some degree of vertical stratification in summer, with limited mixing of water between the warm, nutrient poor, and oxygenated surface waters and cooler, relatively nutrient rich and oxygen depleted water below the thermocline. In shallower water bodies, wind mixing frequently prevents strong or persistent stratification. In fall and spring, stratification breaks down as temperatures cool, and the water column mixes completely as it ‘turns-over”. After ice-out and spring turn-over, many lakes experience a spring bloom of phytoplankton throughout the photic zone of the lake associated with increasing light availability and the availability of nutrients released from the sediments and profundal zone during turnover (Kalff 2003, Dodson 2005).

The spring bloom in the pelagic zone by phytoplankton depletes nutrient concentrations in the upper water column after the thermocline forms, and much of this primary production settles out to the lake sediments. Depending on the degree of stratification, lake temperatures, and amount of organic deposition, oxygen concentrations below the thermocline may depleted to hypoxic (low) or anoxic (no DO) levels by respiring bacteria. Hypoxia and anoxia are rare in oligotrophic or deep lakes. Secondary production of zooplankton peaks in association with the spring bloom, and larval, juvenile, and adult fishes may consume a large proportion of this secondary production and may have strong effects on plankton community composition and structure. During summer, nutrients may cycle rapidly among microbes, phytoplankton, and zooplankton.

Reservoirs differ in at least three important respects from natural lakes. First, reservoirs typically have much greater shoreline development (shoreline / area) because they typically occupy drowned river valleys. Second, though the large amount of shoreline suggests a greater importance of littoral zone processes, this potential is rarely realized because of high frequency and large amplitude fluctuations in water level caused by dam operations. These fluctuations prevent the establishment of well developed littoral communities (Black et al. 2003). Third, large riverine inputs and high flushing rates of many reservoirs alter plankton community dynamics by exporting plankton downstream, and river inputs often create large gradients in nutrient and suspended sediments from reservoir input to dam (output). For example, Barber et al. (1999) classified upper Lake Roosevelt as mesotrophic, but the lower reservoir as oligotrophic, based on primary productivity estimates.

Stressors to lake ecosystems occur at both global/watershed and local scales. Atmospheric deposition of sulfuric and nitric acids (acid rain) and other toxins are important stressors in some regions. This is particularly significant at LARO. One of the most important stressors to lakes is the input of anthropogenic phosphorus and nitrogen, which frequently limit primary productivity. Such cultural eutrophication occurs through point and non-point sources, including atmospheric deposition, septic input, run-off from agricultural application of synthetic fertilizers, and treated and untreated septic and sewer inputs. Cultural eutrophication leads to changes in lake food webs, fisheries, and can exacerbate hypoxia/anoxia events below the summer thermocline.

Sediment loading to lakes may increase with changes in drainage basin land use, and suspended sediments can have strong effects on littoral and pelagic communities, primarily through changes in the light environment (Kalff 2002, Dodson 2005).

Inputs of toxins to lakes, through atmospheric deposition (e.g., mercury) or upstream point and non-point sources enter food webs directly or after chemical transformation in the sediments. Unfortunately, toxins can accumulate at higher trophic levels through biomagnification, leading to poor reproductive success in birds, as in the well known case of DDT, or accumulate to levels that create a health risk when consumed by humans. Lake Roosevelt is currently being considered for addition to the EPA National Priorities List, better known as the "Superfund" list. Lake Roosevelt sediments contain elevated levels of heavy metals (cadmium, copper, lead, mercury, zinc)USGS 2003) and other toxics (e.g., PCBs, dioxins, furans), primarily originating from an upstream smelter in Canada and pulp mills. The Spokane River also contributes heavy metal inputs derived from historical upstream mining sources (Grosbois et al. 2001). PCBs and mercury in fish have been at unsafe levels for human consumption in the past, thereby affecting the recreational quality of fisheries. However, there is some evidence that levels of some toxins such as mercury are declining since decreases in toxin loadings to the river starting in the early 1990s (Munn 2000).

Given the extent of contamination in Lake Roosevelt, avian piscivores such as the osprey are particularly at risk of bioaccumulation. As a top predator, osprey are one of the most vulnerable members of the aquatic ecosystem with regard to contamination effects. Studies have shown that many contaminants-of-concern biomagnify from fish to osprey eggs, sometimes by factors of 10-200 times (Henny et al. 2003).

Many characteristics of osprey make them ideal biological indicators. Not only are they top predators and specialists, but >99% of the fish eaten are captured near the nest site. They often build large, visible nests that are regularly spaced along lake shores making them ideal candidates for assessing changes in spatial patterns. Osprey are long-lived, mate for life, and typically return to the same nest each year (US Geological Survey 2003). One of the largest birds in North America, osprey populations were historically reported as numerous and widespread. Through the mid-1970's, populations drastically declined as a result of pesticide use. Most populations have since recovered and, to some extent, adapted to human-dominated landscapes, nesting on power poles, cellular towers, and channel markers when suitable natural nest sites are scarce (Ewins 1997, US Geological Survey 2003). Osprey are currently found throughout the Columbia River system and several recent osprey-contaminant studies in the region have detailed the spatial extent and level of contamination (Elliott et al. 1998, 2000, 2001; Henny et al. 2003, 2004).

In addition to bioaccumulation, Figure C-19 shows the relationships among other external and internal sources of stress to osprey populations in the upper Columbia Basin. Competition for food with other piscivore species (e.g., bald eagles, otter) and nest predation from raccoons and great-horned owls can influence osprey population dynamics (Ewins 1997). While osprey are fairly adapted to anthropogenic disturbances (Henny and Kaiser 1996, US Geological Survey 2003), changes in land cover / land use, climate, and / or invasive species that result in loss of nesting habitat may impact osprey populations at LARO. These factors, in addition to manipulation of water levels, hydroperiod, and flushing rate, influence the integrity of the lake itself (see Figure C-18) and can impact bird communities indirectly through various fish species.

Perhaps the greatest transformation to the communities of western lentic habitats has resulted from the introduction of exotic species. Reservoirs frequently contain fisheries composed primarily of non-native fishes. The illegal or intentional introduction of non-native game and forage fishes has been widespread (Rahel 2002). Consequently, few UCBN lakes and ponds have natural vertebrate communities. Important introduced fish species in the UCBN region include walleye (*Stizostedion vitreum*), centarchid sunfishes (*Lepomis* spp.), brook, brown, and rainbow trout, carp, tench, large- and smallmouth bass, yellow perch, and black crappie. As part of mitigation offset for anadromous salmonid returns blocked by hydropower dams (Scholz et al. 1985), large numbers of kokanee (land-locked sockeye salmon, *O. nerka*) and rainbow trout continue to be released annually to Lake Roosevelt. These fisheries have failed to meet management goals in terms of production, perhaps due to predation (including walleye, Baldwin et al. 2003), downstream entrainment in Grand Coulee Dam, and hatchery practices (McLellan et al. 2004). Despite this altered fish community, Lake Roosevelt appears to harbor a stable or growing population of burbot (*Lota lota*), a native species thought to be in decline regionally (Bonar et al. 2000).

In ponds and wetlands, the establishment of exotic bullfrogs (*Rana catesbeiana*), in addition to sunfishes and bass, has been implicated in the decline of native amphibians (Adams 2000). Adams et al. (2003) provided experimental evidence that sunfish facilitate bullfrogs in Oregon ponds by depressing native odonates that are otherwise strong predators on bullfrog tadpoles. Introduced aquatic plants also have substantial impacts. At least sixteen exotic aquatic plants have been recorded in the state of Washington (http://www.ecy.wa.gov/programs/wq/plants/weeds/exotic.html). Eurasian milfoil (*Myriophyllum spicatum*) occurs in Snake River reservoirs, where it dominates SAV communities. Two other species have been recorded in eastern Washington, the lilypad yellow floating heart (*Nymphoides peltata*) and the wetland plant purple loosestrife (*Lythrum salicaria*).

C-6. Land Cover Composition, Configuration, and Connectivity

A. Introduction

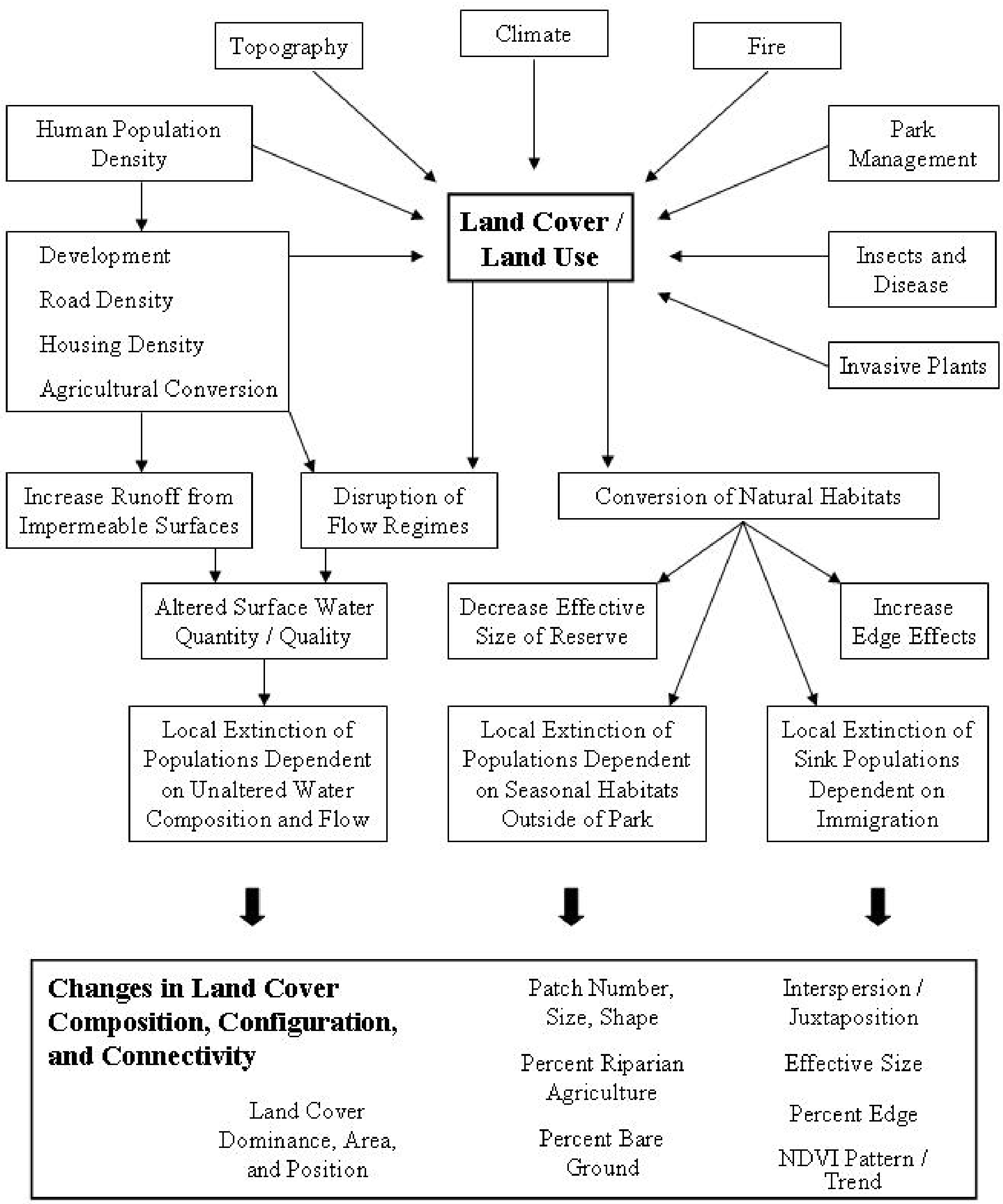
Resiliency of biodiversity in a protected area is intimately tied to the ecological integrity of the matrix within which the area is embedded. Attributes of surrounding landscapes contribute to the abiotic and biotic dynamics of remnant areas (Saunders et al. 1991, Meffe and Carroll 1997) and are major determinants of both short-term and long-term protection effectiveness (Schonewald-Cox 1988). Landcover composition, configuration, and connectivity help shape the complex of species occurring in an area, the movements of individual organisms, and energy and material flows (Dunning et al. 1992, Taylor et al. 1993). Substantial changes in these landcover attributes occur in response to natural and anthropogenic processes. Natural disturbance regimes largely are driven by climatic factors (e.g., Agee 1993, Peet 2000, Reid et al. 2002, Long 2003) and expected changes in climatic conditions may elevate the frequency and/or severity of natural disturbances such as wildfire and insect and disease outbreaks. Discerning between natural and anthropogenic forces of change is also critical to effective mitigation action. Management actions seldom can influence natural processes, but can be effective in mitigating human-induced changes. Anthropogenic disturbance along park boundaries is of special concern as increases in cross-border contrasts can lead to undesirable changes. For instance, habitat fragmentation has been associated with a variety of negative consequences to both wildlife and vegetative communities and also provides the opportunity for invasion of exotic or undesirable species (Wilcove et al. 1986, Yahner and Scott 1988).

Over ten years ago, the National Park System Advisory Board recommended that “resource management should be addressed in broader context” and specifically recognized the impact of activities outside park boundaries (National Park Service 1993). In fact, concerns over external influences date as far back as 1933 (Wright et al. 1933), and management of adjacent lands has been identified as one of, if not the most, serious challenge facing park managers over the last 25 years (Shands 1979, National Parks and Conservation Association 1979, National Park Service 1980, Buechner et al. 1992). The majority of parks are dependent on adjacent lands simply because their boundaries fail to encompass habitats and processes (e.g., migratory species, fire regimes) necessary to maintain complete species communities (Myers 1972, Western 1982, Curry-Lindahl 1972, Garratt 1984). Therefore, threats from outside park boundaries can, and are, significantly modifying biodiversity within the parks (National Parks and Conservation Association 1979, Garratt 1984, Sinclair 1998).

Monitoring long-term changes in landcover composition, configuration, and connectivity may establish a broader context for each park, and can help natural resource managers determine patterns in land use change which may threaten future ecological integrity within parks. Selecting an adequate scale at which to evaluate the effects of landcover change and fragmentation is difficult without first identifying what is being managed (e.g. what species or processes; Beatley 2000) and the scales of disturbance to which those species/processes respond.

B. Land Cover / Land Use Control Model

Figure C-20. Components, effects, and measures of change in land cover and land use in the Upper Columbia Basin Network.



C. Model Narrative

As shown in Figure C-20, a multitude of factors contribute to changes in land cover and land use in UCBN parks and surrounding lands. The presence/absence of different vegetation communities is driven by topography, climate, and natural disturbances such as fire (Agee 1993, Peet 2000, Reid et al. 2002, Long 2003; see also Figure C-7). Human population growth and related developments (housing, roads, and agriculture) are probably the greatest and most widespread impacts on natural habitats (Sisk et al. 1994, Vitousek et al. 1997). These factors lead to altered surface water quantity and quality through the disruption of flow regimes and increased runoff from impervious surfaces (McKinstry et al. 2004, Wissmar 2004). This can then lead to the local extinction of populations dependent on unaltered water regimes. Humans also indirectly affect native land cover through the introduction of invasive species, insects, and our irrepressible need to manage everything from fire to vegetation, wildlife, and the actions of other humans.

Landscapes are not static entities and change is inevitable. While not all changes in land cover are harmful (e.g. succession unassisted by human management such as fire suppression), the expanding human population in the US makes this one of the most significant impacts on native fauna and flora (Wilcove et al. 2000, Shaffer and Stein 2000). The conversion of natural habitats through changes in land cover and/or land use result in numerous stresses that can impact fauna in the area including not only a decrease in the total area of habitat available but also increased edge effects and increased separation distance between patches of habitat. This fragmentation of habitat has been associated with a variety of negative consequences to both wildlife and vegetative communities and also provides the opportunity for invasion of exotic or undesirable species (Wilcove et al. 1986, Yahner and Scott 1988). Combined, these factors may result in a decrease in the effective size of the reserve. It has been hypothesized that only protected areas with adequate expanses of surrounding habitat and linkages to other protected areas will be able to support current levels of biodiversity into the future (Hansen et al. 2001). For species that are dependent on season habitats outside of the park, or populations dependent on immigration, this may result in local extinctions. For example, studies in the Greater Yellowstone Ecosystem have shown that some species cannot persist in the park without access to habitat on adjacent lands, and species dependent on low elevation, riparian, or grassland habitats may be most vulnerable (Hansen and Rotella 2002).

Changes in the land cover and/or land use however, may or may not equate to habitat loss for a particular species of interest depending on the extent and severity of change as well as the degree of specialism in the species. While the "suitability" of any particular landscape for a species is a continuum from suitable to non-suitable, threshold amounts of habitat loss do occur at which a slight decrease of habitat may result in significant changes in species occurrences and/or abundance leading to population extinction (Fahrig 2001). These thresholds are not common across species and may range from <1% to >99% (With and King 1999, Fahrig 2001). Identification of these thresholds through long-term monitoring will be critical in understanding the degree of ecological integrity of UCBN parks and the impacts of regional land cover / land use change.

Appendix D. Workshop Handouts and Results

Appendix D-1. Resource managers responses to questionnaire at 2002 Vital Signs Monitoring Workshop

Park Summaries

Network park site representatives defined their park's ecological concerns in written responses and workshop presentations. Park site representatives addressed site conditions and concerns in the context of the following:

- *What are the park's most significant resources for which information about status and trends is needed?*
- *What park resources have regional or even national significance due to uniqueness, or because they serve as indicators of regional trends?*
- *What are the greatest current or prospective internal threats to significant park resources?*
- *What are the greatest external threats?*

Big Hole National Battlefield (BIHO) Dan Foster

Cultural landscapes are the most significant resources to be protected at BIHO, with invasion of exotic species and changes to local hydrology as both internal and external threats. Over the years, fire has been kept out of the landscape, creating a change in ecology. Additionally, four nearby irrigation canals have leaked, encouraging non-native willow growth. Grazing patterns near park borders have impacted native grasses, as well. BIHO identifies restoration of forest ecology by thinning and prescribed burn, and prescribed fire in willow/riparian and sage/grasslands as ecosystem restoration projects for which long-term monitoring is needed.

Nez Perce National Historical Park (NEPE) Dan Foster

With 38 dispersed cultural landscape locations, the park's sites are all listed on the National Register of Historic Places and are thus in need of protection, especially from encroaching development to satisfy visitor demand. Proposed visitor centers such as those at Bear Paw and Heart of the Monster will impact ecosystems. Currently NEPE's Spalding site needs restoration of ponderosa pine/grass areas, while the White Bird village site requires building removal. All locations suffer some amount of impact from exotic species.

City of Rocks National Reserve (CIRO) Wallace Keck

CIRO's significant resources include the California Trail, Indian Grove and riparian communities, with the area boasting Idaho's largest pinyon pine and a large pinyon pine forest. The park's high elevation supports several distinct plant communities (sagebrush, pinyon-juniper, etc.), and granite monoliths provide shelter for raptors, pack rats, cliff swallows and swifts. The area is a rock-climbing mecca, but current threats from rock climbers are being mitigated. Grazing in riparian areas, dust dispersal from gravel roads, and erosion and sedimentation are additional areas of concern within the park, and juniper theft is an external threat that has become a recent problem.

Craters of the Moon National Monument (CRMO) John Apel

With its borders recently expanded to more than 12 times the original size, CRMO's significant resources include numerous volcanic features, kipukas, a Class I airshed, lava tubes, populations of sage grouse, Townsend's big-eared bats and pygmy rabbits, natural quiet and night skies. The spread of invasive weeds, destruction of geologic features by collectors, and illegal off-road vehicle use pose some of the biggest problems to the park itself. External threats include the spread of invasive weeds, regional haze impacts on visibility, development impacts on night sky, and white pine blister rust impacts on limber pine. Restoration of sagebrush steppe habitat downgraded by wildland fire and invasion of cheat grass is a major focus.

Hagerman Fossil Beds National Monument (HAFO) Mike Wissenbach

Fossils and the associated stratigraphy are HAFO's most significant resources, while landslides, altered hydrological regimes (high water tables, fluctuating reservoir levels, perched aquifers, irrigation) and wind/water erosion pose the biggest threats to slope stability and fossil resources. Restoration and monitoring work would likely focus on revegetation of landslide areas to stabilize slopes, and control of exotic species. This section of the Snake River does not currently meet water quality standards; some of the impacts affect submerged lands that are within monument boundaries.

John Day Fossil Beds National Monument (JODA) Ken Hyde

JODA lists three areas of focus: riparian area vegetation changes; changes in plant communities due to noxious weed invasions and reintroduction of fire; population dynamics of amphibians, reptiles and small rodents. The amphibian population as well as steelhead salmon, bald eagle and Columbia spotted frog, are of concern, and noxious weeds such as cheat grass and medusa head are impacting sagebrush, mountain mahogany and rodent populations. The reintroduction of fire may or may not benefit native plant and animal communities, and newly planted old farm fields should be monitored for noxious weeds, future flood events and benefits to native wildlife populations.

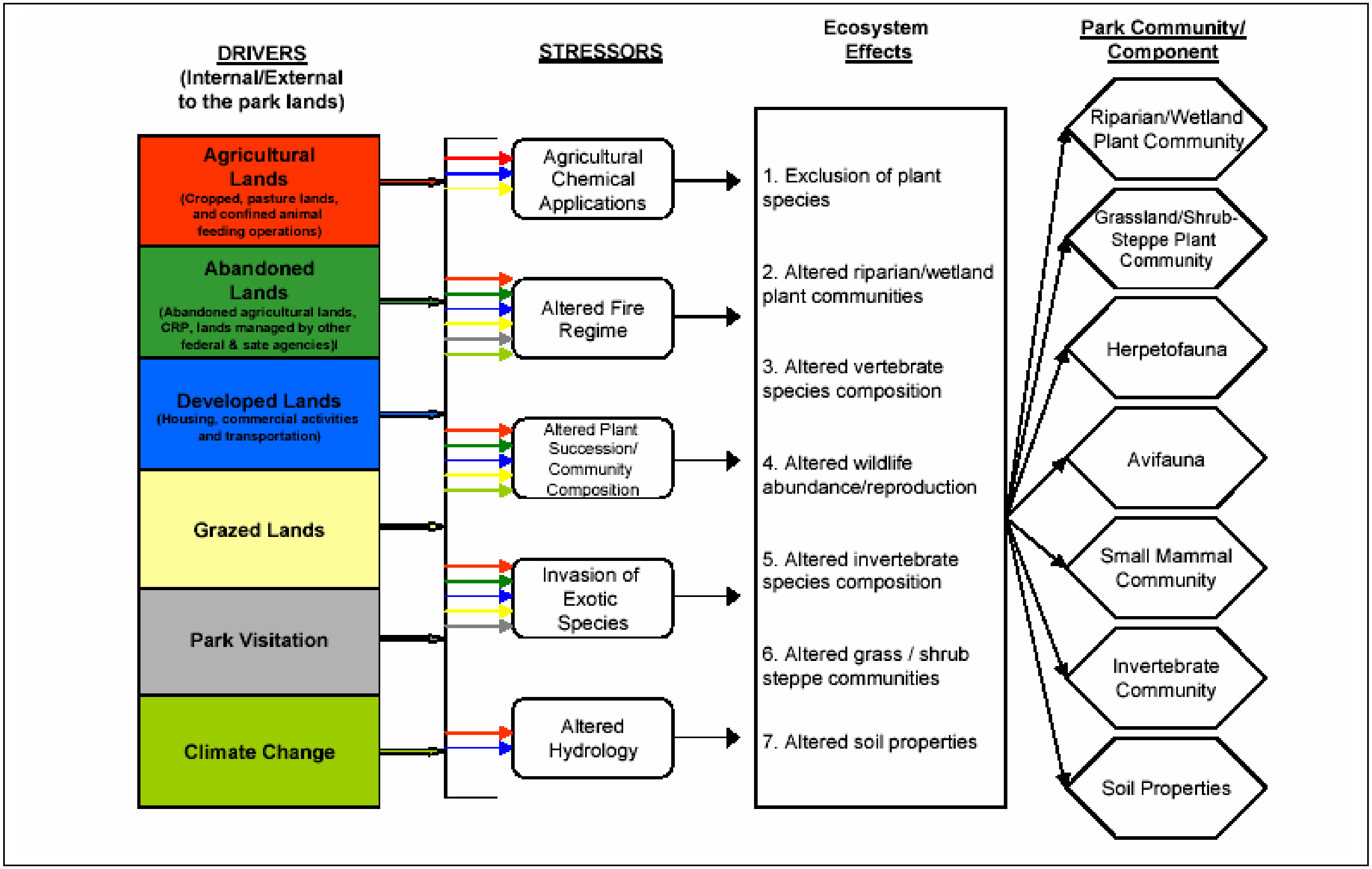
Lake Roosevelt National Recreation Area (LARO) Scott Hebner

LARO's focus concentrates on plant communities, water and fish, with raptors and water birds also of special significance. The mixed ownership and water fluctuations fragment resource management, and industrial pollution, residential development and noxious weeds pose major threats to the landscape. Restoration projects which require monitoring programs include polluted sediment impacts and shrub-steppe and forest restoration. Because the lake is manmade, it is not a natural aquatic environment.

Whitman Mission National Historic Site (WHMI) Roger Trick

WHMI has a cultural resource focus, but native vegetation and surface water quality and quantity are the park's major resource interests for new monitoring programs. As with other network sites, exotic species and noxious weeds are a major concern, as is the quality of irrigation water coming into the park. There is some ongoing vegetation restoration work, which will require monitoring, and water quality monitoring also needs to be undertaken.

1 **Appendix D-2. Conceptual Model Developed from Vital Signs Monitoring Workshop April 2002**



Appendix D-3. Potential UCBN partners

- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- Burke Museum of Natural History and Culture
- Confederated Tribes - Colville Reservation
- Confederated Tribes of Warm Springs
- Cooperative Ecosystem Studies Units
- County Governments
- Idaho Conservation Data Center
- Idaho Department of Fish and Game
- Idaho Geologic Survey
- Idaho Museum of Natural History
- Idaho State Climate Services
- Idaho State University
- Land Trusts
- Montana Natural Heritage Program
- National Gap Analysis Program
- National Resources Conservation Service
- Nez Perce Tribe
- Oregon Department of Fish and Wildlife
- Oregon Museum of Science and Industry
- Oregon Natural Heritage Program
- Oregon State University
- Private Landowners
- Sawtooth Science Institute
- School Districts
- Spokane Tribe of Indians
- The Nature Conservancy
- United States Fish and Wildlife Service
- United States Forest Service
- United States Geological Survey
- University of Idaho
- University of Washington
- Washington Dept. of Fish and Wildlife
- Washington State University

Appendix D-4. Upper Columbia Basin Network Species of Concern List

Sources:

Montana Natural Heritage Program, Idaho Conservation Data Center, Washington Natural Heritage Information System, Washington Department of Fish and Wildlife, Oregon Natural Heritage Program

Note: State lists were crosschecked against existing UCBN species lists, the NPSpecies database, and individual park lists. Unconfirmed species are indicated with the symbol (x). Threatened (T) and endangered (E) species are noted as well as those petitioned under the Endangered Species Act.

Name	BIHO	CIRO	CRMO	HAFO/MIIN	JODA	LARO	NEPE	WHMI
Birds								
American White Pelican		x		x		x	x	
Bald Eagle (T)	x	x	x	x	x	x	x	x
Black Tern			x					
Burrowing Owl		x	x	x				
Columbian Sharp-tailed Grouse			(x)					
Common Loon				x		x		
Common Nighthawk					x			
Eastern Oregon Willow Flycatcher					(x)			
Ferruginous Hawk	x	x	x	x		x	x	x
Golden Eagle						x		x
Great Egret				x				
Greater Sage Grouse (Petitioned)		x	x	(x)				
Greater Sandhill Crane					x	x		x
Lewis's Woodpecker					x	x		x
Loggerhead Shrike		x	x	x	x	(x)		x
Long-billed Curlew		x	x	x				
Merlin						x		x
Mountain Quail					x			
Northern Goshawk	x	x	x	x	x	x		x
Northern Pygmy-owl		x					x	

Name	BIHO	CIRO	CRMO	HAFO/MIIN	JODA	LARO	NEPE	WHMI
Peregrine Falcon			x	x	x	x		x
Pileated Woodpecker						x		x
Sage Thrasher						x		
Three-toed Woodpecker							x	
Tricolored Blackbird					x			
Vaux's Swift						x		x
Western Bluebird					x			
Western Grebe						x		
Western Meadowlark					x			
White-faced Ibis			x		x			
White-headed Woodpecker						x		
Yellow-breasted Chat					x			
Mammals								
California Bighorn Sheep					x			
Canada Lynx (T)	(x)							
Cliff Chipmunk		x						
Fringed Myotis		x	x	(x)	x	x	(x)	
Gray Wolf (EXPN)	x		(x)					
Grizzly Bear (T)	(x)							
Kit Fox			(x)					
Long-eared Myotis		x	x	(x)	x	x		
Long-legged Myotis		x	x	(x)	x			
Merriam's Shrew		(x)	(x)	(x)	(x)	(x)		
Pallid Bat					x			
Pygmy Rabbit (Petitioned)		(x)	(x)					
Silver-haired Bat					x			
Spotted Bat		x			x	(x)	(x)	
Townsend's Big-eared Bat		(x)	x	(x)	x	(x)	(x)	
Western Small-footed Myotis		x	x	(x)	x			
Yuma Myotis			x	(x)	x	x		

Name	BIHO	CIRO	CRMO	HAFO/MIIN	JODA	LARO	NEPE	WHMI
Herpetofauna								
Columbia Spotted Frog (Candidate)	(x)		(x)			(x)	(x)	
Common Garter Snake			(x)		x			
Ground Snake				(x)				
Longnose Snake				(x)				
Mojave Black-collared Lizard			(x)					
Northern Leopard Frog			(x)	(x)				
Ringneck Snake							x	
Short-horned Lizard			x					
Western Rattlesnake					x			
Western Toad	(x)	x	(x)		x	x	x	(x)
Fish								
Arctic Greyling	(x)							
Bull Trout (T)					x	x		
Interior Redband Trout					x			
Malheur Mottled Sculpin					x			
Pacific Lamprey					x			
Steelhead, Middle Columbia ESU (T)					x			
Invertebrates								
Banbury Springs Limpet (*Lanx*) (E)				(x)				
Blind Cave Leiodid Beetle			x					
Bliss Rapids Snail (T)				(x)				
Desert Valvata				(x)				
Idaho Dunes Tiger Beetle			(x)					
Idaho Pointheaded Grasshopper			(x)					
Idaho Springsnail (E)				(x)				
Snake River Physa (E)				(x)				
Plants								
Allium aaseae			(x)					
Allium anceps			x					

Name	BIHO	CIRO	CRMO	HAFO/MIIN	JODA	LARO	NEPE	WHMI
Antennaria arcuata			(x)					
Antennaria parvifolia						x		
Astragalus atratus var. *inseptus*			x	x				
Astragalus collinus					x			
Astragalus diaphanus var. *diurnus*					x			
Astragalus oniciformis			x					
Astragalus pushii var. *ophiogenes*				x				
Botrychium spp. (Candidate)					(x)			
Cymopterus davisii		x						
Downingia bacigalupii			x					
Eriogonum shockleyi var. *shockleyi*				x				
Luina serpentina					x			
Mimulus evanescens					x			
Oxytropis campestris var. *columbiana*						x		
Pediocactus simpsonii		x						
Penstemon lemhiensis	x							
Phacelia inconspicua			x					
Polystichum kruckebergii		x						
Pyrrocoma insecticruris			x					
Salix candida						x		

Appendix D-5. Noxious Weeds of UCBN Parks

Note: This list was assembled from “top 10” lists provided by each network park, EPMT reports, and 2003 University of Idaho weed team reports.

Common Name	Scientific Name	BIHO	CIRO	CRMO	HAFO	JODA	LARO	MIIN	NEPE	WHMI	Total
Canada Thistle	*Cirsium arvense*	x	x	x	x		x	x	x	x	8
Spotted Knapweed	*Centaurea maculosa*	x	x	x		x	x		x		6
Toadflax	*Linaria spp.*	x	x	x		x	x		x		6
Cheatgrass	*Bromus tectorum*	x		x	x	x		x		x	6
Scotch Thistle	*Onopordum acanthium*		x	x				x	x	x	5
Yellow Starthistle	*Centaurea solstitialis*					x	x	x	x	x	5
Diffuse Knapweed	*Centaurea diffusa*	x		x	x	x	x				5
Russian Knapweed	*Acroptilon repens*	x		x		x	x	x			5
Field Bindweed	*Convolvus arvensis*	x	x		x			x	x		5
Rush Skeletonweed	*Chondrilla juncea*			x	x		x	x			4
Houndstongue	*Cynoglossum officinale*		x			x	x		x		4
Bull Thistle	*Cirsium vulgare*	x	x		x			x			4
Common Mullein	*Verbascum thapsus*				x		x	x			3
Poison Hemlock	*Conium maculatum*		x						x	x	3
Leafy Spurge	*Euphorbia esula*	x		x			x				3
Common Tansy	*Descuriania pinnata*	x		x					x		3
Musk Thistle	*Carduus nutans*		x					x			2
Prickly Sowthistle	*Sonchus asper*				x			x			2
Common Teasel	*Dipsacus fullonum*				x				x		2
Black Henbane	*Hyoscyanus niger*	x	x								2
Bedstraw	*Galium aparine*									x	1
Burdock	*Arctium minus*							x			1
Chicory	*Chicorium intybus*		x								1
Dyer's Woad	*Isatis tinctoria*		x								1

Common Name	Scientific Name	BIHO	CIRO	CRMO	HAFO	JODA	LARO	MIIN	NEPE	WHMI	Total
Kochia	*Kochia scoparia*									x	1
Longspine Sandbur	*Cenchrus longispinus*						x				1
Medusahead	*Elymus caput-medusae*					x					1
Perennial Pepperweed	*Lepidium perfoliatum*					x					1
Prickly Lettuce	*Lactuca serriola*									x	1
Puncturevine	*Tribulus terrestris*						x				1
Purple Loosestrife	*Lythrum salicaria*				x						1
Reed Canary Grass	*Phalaris arundinaceae*									x	1
Russian Thistle	*Salsola kali*						x				1
Saltcedar	*Tamarix ramosissima*				x						1
Spikeweed	*Hemizonia pungens*									x	1
Whitetop	*Cardaria draba*					x					1

Appendix D-6. Prioritized Stressors Affecting Park Natural Resources in the Upper Columbia Basin Network

Stressor: any physical, chemical, or biological entity or process that can induce an adverse response. For purposes of monitoring, stressors are considered to be anthropogenic factors that are outside the range of disturbances naturally experienced by the ecosystem.

Priority Scale: High=3, Medium=2, Low=1, None=0; Priority reflects degree to which stressor is impacting park resources NOT a prioritization of future monitoring activities.

Stressors	BIHO	CIRO	CRMO	HAFO	JODA	LARO	MIIN	NEPE	WHMI	Total
Exotic Plants	3	3	3	3	3	3	3	3	3	27
Agriculture on Adjacent Lands (Water Diversion, Chemical Use, Livestock etc.)	3	1	2	3	2	2	3	2	3	21
Fire Management Practices (NPS and Adjacent Lands)	2	2	2	2	3	3	1	2	2	19
Other NPS Management (Weed Control, Agriculture, Restoration, Reintroductions, etc.)	3	2	1	1	2	2	3	2	3	19
Other Historic Human Impacts (Sagebrush Removal, Irrigation etc.)	2	1	1	3	2	1	3	2	3	18
NPS Development (Facilities, Trails, Campgrounds, Roads, etc.)	3	3	1	1	1	2	1	3	1	16
Historic Livestock Grazing	2	3	2	2	2	1	2	2	0	16
Visitation/Recreation (Boating, Hiking, Climbing, ORV, etc.)	1	3	2	1	1	3	1	1	1	14
Historic Fire Suppression	2	2	2	1	2	2	1	2	0	14
Landscape Fragmentation	2	1	1	1	1	1	2	2	3	14
Exotic Animals (Including Livestock Trespass)	1	1	1	1	2	2	1	1	3	13

Stressors	BIHO	CIRO	CRMO	HAFO	JODA	LARO	MIIN	NEPE	WHMI	Total
Extreme Disturbance Events (Flood, Fire, Drought, Landslides, etc.)	1	1	1	3	1	1	1	1	1	11
Wildlife Impacts (Browsing, Other Damage)	1	1	1	1	2	1	1	1	1	10
Global Warming/Climate Change	1	1	2	1	1	1	1	1	1	10
Hunting (NPS and adjacent lands)	1	1	1	1	1	2	1	1	0	9
Urban Development (Housing, Roads etc.)	1	0	1	0	0	2	1	1	3	9
Exotic Disease Organisms	1	2	2	0	0	0	1	1	1	8
Forest Management Practices (NPS and Adjacent Lands)	2	0	1	0	0	3	0	2	0	8
Dams or Reservoir Operations	0	0	0	3	0	3	0	0	0	6
Permitted Livestock Grazing	0	3	0	0	0	3	0	0	0	6
Utilities/Industry	0	0	1	1	0	3	0	1	0	6
Collection/Poaching	0	1	1	1	2	1	0	0	0	6
Air Traffic	0	1	2	0	0	1	0	0	0	4

Appendix D-7. The UCBN Vital Signs and Associated Monitoring Objectives from Phase 1.

Level 1	Level 2	UCBN Vital Sign	Monitoring Objective	Monitoring Category
Air and Climate	Air Quality	Air Chemistry - ozone	Determine status and track trends in ozone injury occurring in sensitive plant species across the UCBN.	Stressor Effects
		Air Chemistry- Emissions	Determine status and track trends in atmospheric pollutant emissions present in UCBN parks from adjacent agriculture, urbanization, and industry.	Stressor Effects
		Air Chemistry- Mercury	Track trends in mercury deposition at LARO.	Stressor Effects
		Visibility	Track trends in UCBN viewsheds.	Stressor Effects
	Weather	Climate Change	Monitor key measurable climate change parameters to determine rate and extent of climate change in the UCBN.	Baseline
Geology and Soils	Geomorph- ology	Landslides	Track trends in landslides at HAFO.	Stressor Effects
		Channel/Bank Morphology	Track changes in morphology of stream bank and other riparian features in the UCBN.	Baseline
		Paleontological Resources	Monitor trends of in-situ paleontological resources in the UCBN.	Baseline
		Archaeological Resources	Determine the status and trends of visitor damage to in-situ archaeological resources.	Stressor Effects
		Cave features	Determine the type, rate, and extent of damage or impacts from visitors on UCBN geologic features.	Stressor Effects
		Volcanic features	Determine the type, rate, and extent of damage or impacts from visitors on UCBN geologic features.	Stressor Effects
		Cliffs and other geologic features	Determine the type, rate, and extent of damage or impacts from visitors on UCBN geologic features.	Stressor Effects
		Pictographs and rock inscriptions	Determine the status and track changes in pictographs and rock inscriptions in JODA and CIRO.	Baseline
	Soil Quality	Soil Erosion	Track trends in soil erosion	Baseline
		Soil Biota	Determine the status and track changes in soil biota of UCBN riparian areas.	Baseline
		Bare soil surface	Track trends in the amount and spatial pattern of bare soil surface.	Baseline
		Soil Chemistry	Determine the status and trends of mercury contamination in sediments and soils of Lake Roosevelt.	Baseline
		Soil Compaction	Determine status and measure changes in soil compaction before and after park management and in areas of heavy visitor use.	Stressor Effects

Level 1	Level 2	UCBN Vital Sign	Monitoring Objective	Monitoring Category
		Biological Soil Crusts	Determine the status and trends of biological soil crust communities in sagebrush-steppe areas of the UCBN.	Baseline
		Biological Soil Crusts	Determine the status and trends of biological soil crust communities in sagebrush-steppe areas of the UCBN before and after prescribed and wildfire events.	Stressor Effects
Water	Hydrology	Surface Water Dynamics	Determine the status and trend of surface water quantity in the UCBN, including flow in streams, springs, and seeps.	Baseline
	Water Quality	Water Quality- Core Parameters	Track changes in core water quality parameters in the UCBN.	Stressor Effects
		Water quality- Nutrients	Track changes of nutrient levels in UCBN water bodies.	Stressor Effects
		Water Quality- Toxics	Track changes in toxic pollutant levels in water and sediment of Lake Roosevelt.	Stressor Effects
		Water Quality- Macroinvertebrates	Determine the status and track changes in the species and functional group composition of dragonflies and damselflies in the UCBN.	Baseline
		Water Quality- Macroinvertebrates	Determine the status and track changes in the species and functional group composition and abundance of aquatic macroinvertebrates in the UCBN.	Baseline
Biological Integrity	Invasive Species	Invasive Plants	Monitor the status and trend of invasive plants along roads, trails, and other park facilities.	Stressor Effects
		Invasive Plants	Document changes in established populations of invasive species, including response to treatment.	Baseline
		Invasive Plants	Use monitoring data for early detection & predictive modeling of incipient invasive species.	Baseline
		Exotic Vertebrates	Determine the status and track changes in populations of invasive exotic vertebrates in the UCBN.	Baseline
	Infestations and Disease	Forest Insect Pests	Monitor P-J woodlands in CIRO and other UCBN juniper systems for *Ips* infection.	Stressor Effects
		Forest Rust Disease	Monitor limber pine stands in CRMO for early detection and increase of white pine blister rust infection.	Baseline
	Focal species or Community	Cave Biota	Determine the status and trend of cave-obligate organisms in CRMO.	Baseline
		Forest Structure	Track spatial and temporal patterns in the distribution, recruitment, and persistence of snags and downed wood in UCBN forest and woodlands ecosystems.	Baseline
		Ponderosa Pine Forests	Determine trends in ponderosa pine forest composition and structure in the UCBN.	Baseline
		Ponderosa Pine Forests	Track changes in composition, structure, and landscape pattern of ponderosa pine vegetation.	Baseline

Level 1	Level 2	UCBN Vital Sign	Monitoring Objective	Monitoring Category
		Pinyon-Juniper Communities	Track expansion of P-J woodland into sagebrush-steppe ecosystems of the UCBN.	Baseline
		Pinyon-Juniper Communities	Determine trends in pinyon-juniper vegetation composition and structure in the UCBN.	Baseline
		Pinyon-Juniper Communities	Track changes in composition, structure, and landscape pattern of pinyon-juniper vegetation.	Baseline
		Aspen Communities	Determine trends in aspen vegetation composition and structure in the UCBN.	Baseline
		Aspen Communities	Determine the reproductive status and trends of aspen in the UCBN.	Baseline
		Aspen Communities	Track changes in composition, structure, and landscape pattern of aspen vegetation.	Baseline
		Wetland/Riparian Communities	Determine trends in wetland and riparian vegetation composition and structure in the UCBN.	Baseline
		Wetland/Riparian Communities	Track changes in composition, structure, and landscape pattern of wetland and riparian vegetation.	Baseline
		Sagebrush Communities	Determine trends in sagebrush-steppe vegetation composition and structure in the UCBN.	Baseline
		Butterfly/Moth Communities	Identify important lepidoptera-plant relationships in the UCBN and track lepidoptera populations over time.	Baseline
		Invertebrate Communities	Determine the status and trend of selected invertebrate focal species and communities.	Baseline
		Freshwater Mussel Communities	Determine the status and trend of freshwater mussels in the Snake River adjacent to HAFO and along the John Day River at JODA.	Baseline
		Cold-water fish	Determine the status and trend of cold-water fish species of concern, including steelhead.	Baseline
		Frogs	Use monitoring data to determine the impact of spring drawdown of Lake Roosevelt on Pacific tree frog and long-toed salamander reproduction.	Stressor Effects
		Reptiles	Determine the status and track changes in the populations of relict and small populations of reptile species of concern.	Baseline
		Reptiles	Track changes in snake hibernacula.	Baseline
		Forest Bird Communities	Track forest obligate bird community composition, species abundance, and reproductive success.	Baseline
		Shrub-steppe Bird communities	Track sagebrush-steppe obligate bird community composition, species abundance, and reproductive success.	Baseline
		Wetland/Riparian Bird Communities	Track wetland/riparian obligate bird community composition, species abundance, and reproductive success.	Baseline
		Raptor Communities	Determine the status and trend of raptors that breed and winter in the UCBN.	Baseline

Level 1	Level 2	UCBN Vital Sign	Monitoring Objective	Monitoring Category
		Small Mammals	Determine the status and trend of habitat-specific small mammals, such as the water shrew, sagebrush vole, and Merriam's shrew in the UCBN?	Baseline
		Bats-Roosts	Identify and monitor roosts of pallid bat, Townsend's big-eared bat, and other colonial roosting bat species of concern in the UCBN.	Baseline
		Bats-Communities	Track spatio-temporal patterns of bat species presence and activity along important riparian foraging areas in the UCBN.	Baseline
		Network Species/Community of Special Concern	Track changes in the areal extent and density of camas in relation to land use practices in NEPE and BIHO.	Stressor Effects
	At-risk Biota	State and Federal Species of Concern	Determine trends in populations of threatened, endangered, and at-risk species within the parks.	Baseline
		Federal T&E Species	Determine trends in populations of threatened, endangered, and at-risk species within the parks.	Baseline
		Peripheral/Relict Species	Monitor the distribution of peripheral vertebrate species, such as pika, pinyon mice, cliff chipmunk, ringtail, western whiptail, and northern mockingbird to track range expansion and contraction	Baseline
		Snag/Cavity Obligate Species	Determine the status and trend of snag and downed wood-dependent forest invertebrates and vertebrates in UCBN forest and woodland habitats.	Baseline
Human Use	Point Source Human Effects	Fire Control	Conduct pre and post prescribed fire monitoring of plant and animal communities in the UCBN.	Effectiveness
		Invasive Plant Control	Conduct pre and post control monitoring of plant communities in weed treatment areas in the UCBN.	Effectiveness
		Bioaccumulation of Toxins	Conduct monitoring of toxicity levels in selected species of waterfowl, fish, and other species at risk of bioaccumulations in Lake Roosevelt.	Stressor Effects
	Non-point Source Human Effects	Hunting	Conduct monitoring of at-risk natural resources during hunting season, conduct interviews of hunters, etc…to determine the extent and trend of impacts from within-park hunting and poaching.	Stressor Effects
	Consumptive Use	Grazing	Use monitoring data to determine the impacts of permitted livestock grazing in vulnerable ecosystems of CIRO, NEPE, and LARO.	Stressor Effects
		Visitor Usage	Track changes in visitation and in spatio-temporal patterns of park use by visitors.	Baseline
	Visitor and Recreation Use	Dark night sky	Track trends in UCBN viewsheds.	Stressor Effects

Level 1	Level 2	UCBN Vital Sign	Monitoring Objective	Monitoring Category
Ecosystem Pattern and Processes	Fire	Fire Dynamics	Track spatial and temporal changes and variability in wildfire events across the UCBN.	Baseline
		Fire Dynamics	Conduct pre and post fire monitoring of plant communities, including sagebrush-steppe and forested ecosystems of the UCBN.	Effectiveness
		Fire Dynamics	Conduct pre and post fire monitoring of vulnerable plant and animal communities and species.	Effectiveness
		Fuel Dynamics	Monitor pre and post thinning snag and downed wood resources in LARO.	Effectiveness
	Land Use and Cover	Land Use Change	Document changes in development, land conversion, and succession outside UCBN park boundaries.	Baseline
		Landscape Fragmentation and Connectivity	Determine trends in a suite of landscape metrics including patch shape, size, and connectivity	Baseline
		Viewshed	Track trends in UCBN viewsheds.	Stressor Effects
	Soundscape	Soundscapes	Track changes in soundscapes in vulnerable UCBN parks, including WHMI, LARO, and NEPE.	Stressor Effects

Appendix D-8. Screen captures from the Microsoft ACCESS database used to help prioritize vital signs.

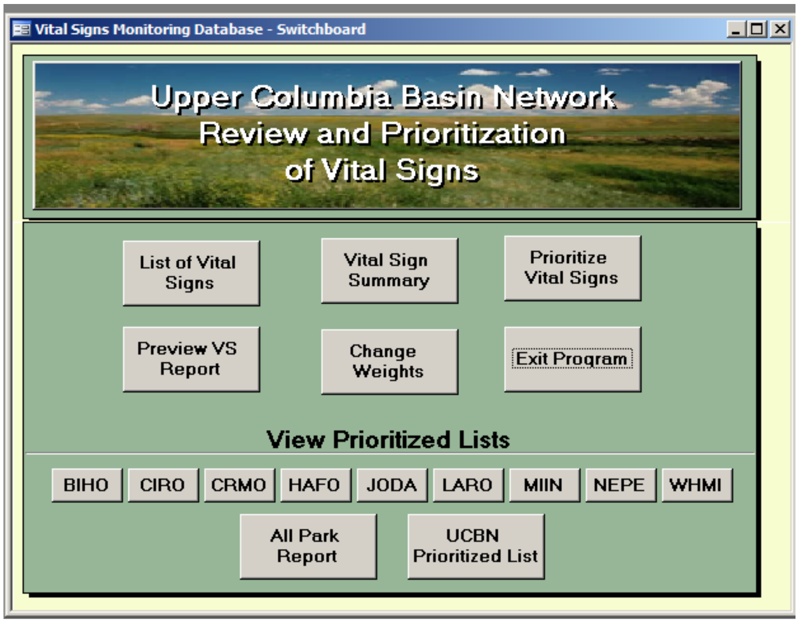


Figure D-1. Vital signs database switchboard with links to the list of vital signs in the national framework, descriptions of the vital signs, reports, weights, and prioritizing screen.

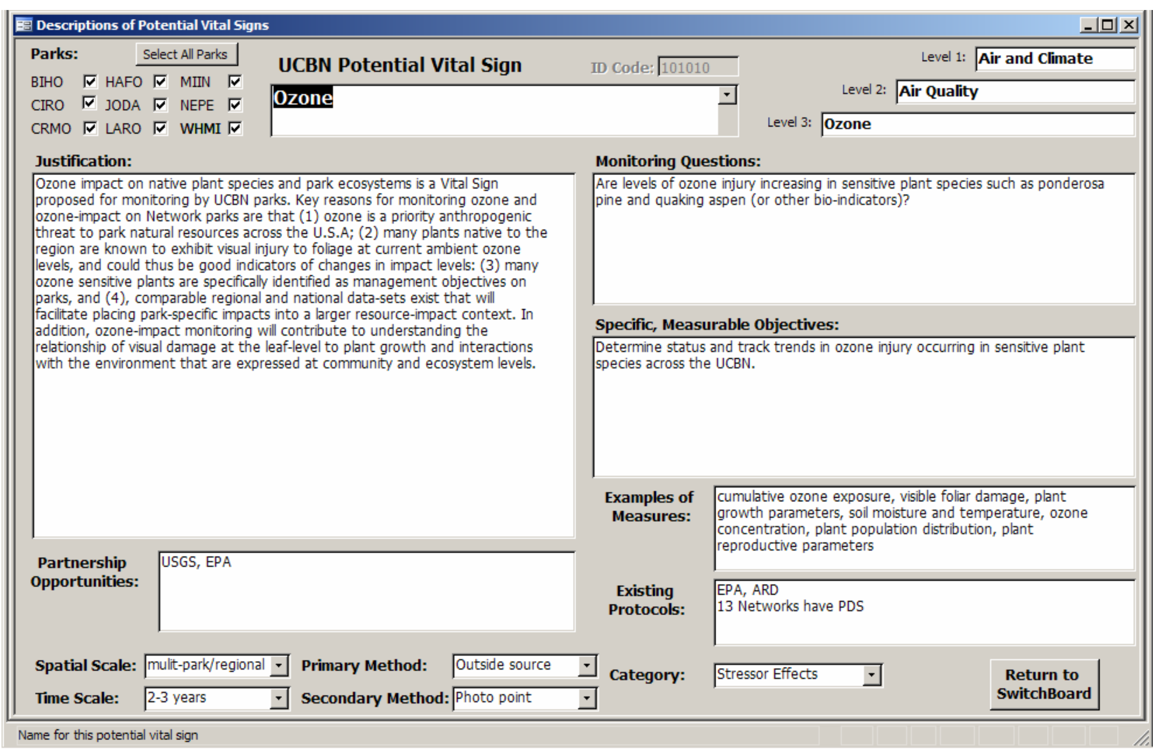


Figure D-2. Descriptions of potential vital signs including justification, questions, objectives, measures, existing protocol, and potential partnerships.

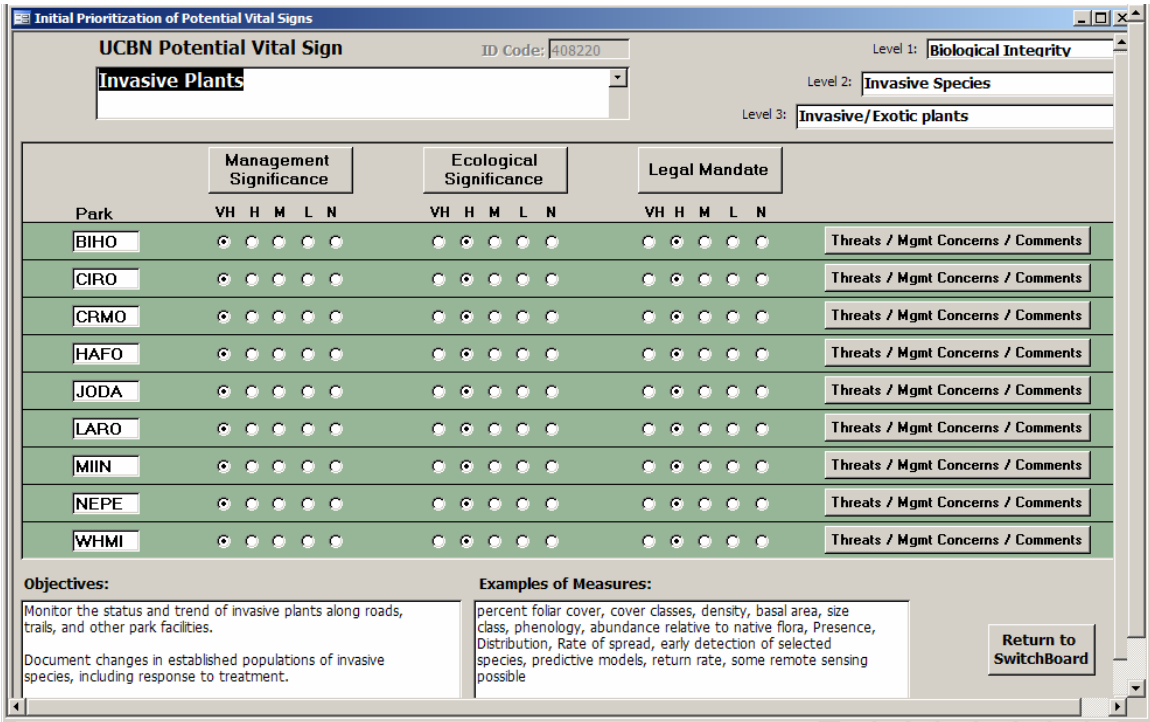


Figure D-3. Input screen used to prioritize each vital sign for management significance, ecological significance, and legal mandate.

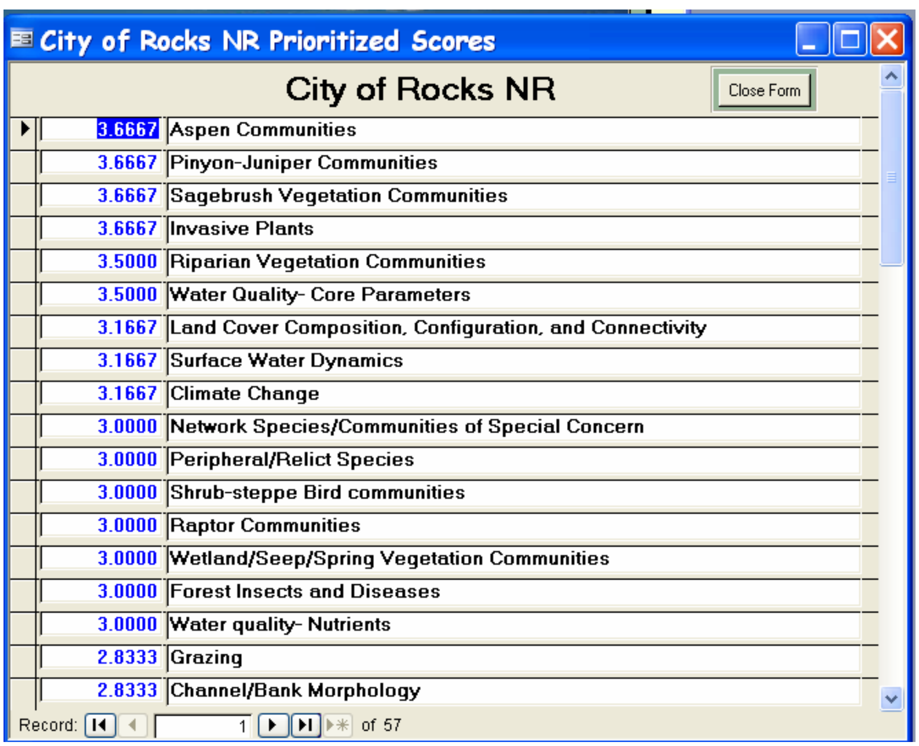


Figure D-4. Example report of the prioritized scores created for each park.

Appendix D-9. Top ten prioritized vitals signs for individual UCBN parks. MIIN is not included - vital signs will be decided for this park after restoration of the cultural landscape complete.

Big Hole National Battlefield
Water Quality- Core Parameters
Channel/Bank Morphology
Invasive Plants
Surface Water Dynamics
Land Cover Composition, Configuration, and Connectivity
Forest Structure
Sagebrush Vegetation Communities
Riparian Vegetation Communities
Viewshed
Network Species/Communities of Special Concern
City of Rocks National Reserve
Aspen Communities
Pinyon-Juniper Communities
Sagebrush Vegetation Communities
Invasive Plants
Riparian Vegetation Communities
Water Quality- Core Parameters
Land Cover Composition, Configuration, and Connectivity
Surface Water Dynamics
Climate Change
Network Species/Communities of Special Concern
Craters of the Moon National Monument and Preserve
Sagebrush Vegetation Communities
Invasive Plants
Network Species/Communities of Special Concern
Land Cover Composition, Configuration, and Connectivity
Bats
Shrub-steppe Bird communities
Forest Insects and Diseases
Water Quality- Core Parameters
Surface Water Dynamics
Climate Change
Hagerman Fossil Beds National Monument
Invasive Plants
Landslides
Sagebrush Vegetation Communities
Land Cover Composition, Configuration, and Connectivity
State and Federal Species of Concern
Riparian Vegetation Communities
Soil Erosion
Biological Soil Crusts
Wetland/Riparian Bird Communities
Shrub-steppe Bird communities

John Day Fossil Beds National Monument
Sagebrush Vegetation Communities
Invasive Plants
Paleontological Resources
Riparian Vegetation Communities
Water Quality- Core Parameters
Bats
Land Cover Composition, Configuration, and Connectivity
Fire Dynamics - Prescribed Fire
Visitor Usage
State and Federal Species of Concern
Lake Roosevelt National Recreation Area
Water Quality-Toxics
Invasive Plants
Riparian Vegetation Communities
Land Cover Composition, Configuration, and Connectivity
State and Federal Species of Concern
Ponderosa Pine Forests
Viewshed
Grazing
Snag/Cavity Obligate Species
Raptor Communities
Nez Perce National Historical Park
Invasive Plants
Federal T&E Species
Water Quality- Core Parameters
Land Cover Composition, Configuration, and Connectivity
Network Species/Communities of Special Concern
State and Federal Species of Concern
Riparian Vegetation Communities
Surface Water Dynamics
Wetland/Riparian Bird Communities
Channel/Bank Morphology
Whitman Mission National Historic Site
Invasive Plants
Fire Dynamics - Prescribed Fire
Water Quality- Core Parameters
Land Cover Composition, Configuration, and Connectivity
Riparian Vegetation Communities
Channel/Bank Morphology
Water quality- Nutrients
Surface Water Dynamics
Wetland/Riparian Bird Communities
Amphibians

Appendix E. Sources for Monitoring Data

Appendix E-1. Existing monitoring programs at Craters of the Moon National Monument and Preserve.

Program	# of sites	Frequency	Month(s) of Year	Comments
Air Resources				
National Acid Deposition Program	1	1/week	1-12	1980-present http://nadp.sws.uiuc.edu/sites/siteinfo.asp?id=ID03&net=NADP
Ozone	1	continuous	1-12	NPS 1992-present (currently DOE funded)
Visibility, Fine Particulates	1	Samplers run every third day; filter change 1/week	1-12	Interagency Monitoring of Protected Visual Environments (IMPROVE); http://vista.cira.colostate.edu/improve/ Module A 1992-2000, Modules A-D 2000-present
Visibility Camera (35mm color slides)	1	3/day	NA	NPS 1985-2001, Discontinued
Gross Alpha & Beta radiation, Gamma Spectrometry (Iodine-131)	1	weekly	1-12	DOE/INL Environmental Surveillance Program http://www.stoller-eser.com/Surveillance.htm
Gamma Spectrometry (Cesium 137)	1	quarterly	1-12	DOE/INL Environmental Surveillance Program http://www.stoller-eser.com/Surveillance.htm
Tritium (atmospheric moisture)	1			State of Idaho/INL Oversight Program http://www.oversight.state.id.us/monitoring/air/index.htm
Gross Alpha & Beta radiation,	1	weekly	1-12	State of Idaho/INL Oversight Program http://www.oversight.state.id.us/monitoring/air/index.htm
Wildlife				
Mule Deer (spring)	Loop Road	As observed	4-5	NPS 1991-present
Mule Deer (fall)	"North End" Route	8/year	Mid-Aug. to Mid- Sept.	NPS 1989-present
Breeding Bird Surveys	10	Each route 1/year	5-6	NPS 1997-present
Weather/Climate				
Climate Reference Network	1	Continuous	1-12	NOAA- Temperature, solar radiation RH, Wind Speed, precipitation (2003-present) http://www.ncdc.noaa.gov/oa/climate/uscrn/

Program	# of sites	Frequency	Month(s) of Year	Comments
Cooperative Network	1	daily	1-12	NWS- temperature maximum/minimum, precipitation (1958-present) http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?idcrat
Ozone MET (VC)	1	Continuous	1-12	Temperature, wind speed/direction, solar radiation, RH (1992-present)
Broken Top	1	Continuous	1-12	DOE/NOAA – Temperature, wind speed/direction, RH, dew point (1997-present) http://www.met.utah.edu/cgi-bin/roman/meso_base.cgi?stn=COMID
Geology				
Geologic Features Photo Points	18	3-5 years	5-8	NPS 1996-Present
Vegetation				
Vegetation Transect	8	Every 4 years	6-7	NPS 1990-Present. Stratified by vegetation type (sagebrush, limber pine, aspen/riparian, cinder, Douglas fir
Landscape Photo Points	annual	6-7	6-7	NPS 1997-present (Note: historical photos date as early as 1920's)
Water Resources				
Water Quality	8			NPS, 4 stream sites & 4 water holes; Core Parameters, nutrients, metals

Appendix E-2. Available Geographic Information System (GIS) and Remotely Sensed (RS) data for the Upper Columbia Basin.

A tremendous amount of GIS and RS data have been developed and gathered for lands encompassed by the UCBN. Over 170 different data layers were compiled or created in support of the Interior Columbia Basin Ecosystem Management Project, whose boundary includes >90% of the network. Gap Analysis Projects have been completed in each of the 4 states, generating 300+ vertebrate species models and supporting data per state. In addition, over a dozen well-known groups specializing in GIS and RS research and data delivery reside in the region. These information sources include the Wildlife Spatial Analysis Lab (Univ. of Montana), USFS Fire Sciences Lab (Univ. of Montana), Montana Natural Resource Information System, Landscape Dynamics Lab (Univ. of Idaho), Remote Sensing and GIS Research Lab (Univ. of Idaho), Inside Idaho (Univ. of Idaho), Idaho Department of Water Resources, GIS Training and Research Center (Idaho State Univ.), Oregon Geospatial Data Clearinghouse, Oregon / Washington Bureau of Land Management, Washington Department of Ecology, Washington Department of Transportation, USFS Pacific Northwest Research Station, USGS Snake River Field Station, StreamNet, and SageMap.

The majority of data available in the region are mid to broad-scale (1:100,000 – 1:500,000), providing excellent opportunities to develop long-term monitoring schemes within the "big picture" context. Many fine scale (1:24,000) data layers are also available and, given the expertise in the region, additional park and management specific data could easily be generated. The following table identifies GIS and RS data currently available.

Theme	Data	Scale	BIHO	CIRO	CRMO	HAFO	MIIN	NEPE	JODA	LARO	WHMI
Air/Climate	Air Quality Point Source Emissions	1:100									
	Superfund Sites	1:100									
	Weather (8 Variables)	1:100									
Hydrology	Rivers	1:100									
	Lakes	1:100									
	Gaging Stations	1:100									
	Impoundments	1:100									
	Water Quality Stations	1:100									
	Springs	1:100									
	Waterholes	1:100									
	Wetlands	1:100									

Theme	Data	Scale	BIHO	CIRO	CRMO	HAFO	MIIN	NEPE	JODA	LARO	WHMI
	Basin and Subbasin Boundaries	1:100									
	Pollutant Sources	1:100									
	Water Quality Impaired Lakes and Streams	1:100									
	Water Stress Index	1:100									
Topography/Geology	Contours	Varies									
	Digital Elevation Model	30m									
	Digital Elevation Model	10m						part			
	Land Slides	1:24									
	Paleontological Sites	1:24									
	Geology	Varies									
	Soil Survey	1:24			part						
	Caves	1:24			part						
	Nutrient Availability Index	1:100									
	Bedrock Mineral Content	1:100									
	Major Lithology	1:100									
	Low-Temperature Geothermal Sites	1:100									
	Mines (Mineral Industry Locator System)	1:100									
Vegetation	Land Cover	1:100									
	Land Cover	1:24			part						
	Weed Locations	1:24			part						
	Weed Treatments	1:24								part	
	Kipukas	1:24									
	Rare Plant Locations	1:100			part						
	Vegetation Transects	1:24			part						
	Forest Health Vegetation Vulnerability	1:100									
	Rangeland Health Vegetation Vulnerability	1:100									
	Distribution Artemisia tridentata (Double CO2)	1:100									
	Distribution Pinus Ponderosa (Double CO2)	1:100									
	Historic (1936) Vegetation	1:100									
	Net Primary Productivity	1:100									

Theme	Data	Scale	BIHO	CIRO	CRMO	HAFO	MIIN	NEPE	JODA	LARO	WHMI
Wildlife	Sage Grouse Leks	1:100									
	Sensitive Species Locations	1:100									
	Breeding Bird Survey Routes	1:100									
	Relative Aquatic Integrity	1:100									
	Fish Species Ranges, Current and Historic	1:100									
	Wildlife Habitat Relationship Models	1:100									
Political	State Boundaries	1:100									
	County Boundaries	1:100									
	Cities	1:100									
	Park Boundaries	1:100									
	Ownership	1:100									
	Parcel Tracts	1:24						part			
	Other Protected Areas	1:100									
	Wilderness Study Areas	1:100									
	Campgrounds / Parking Areas	1:100									
	Highway Mile Markers	1:100									
	Road Density	1:100									
	Roads	1:100									
	4WD Roads	1:100									
	Trails	1:100									
	Utility Corridors	1:100									
	Railroads	1:100									
Cultural	Archeological Sites	1:24			part						
	Historic Photo Series Locations	1:24									
	Structures	1:24						part			
	Historic Trails	1:24									
	Cultural Resource Sites	1:24						part			
	Scenic Integrity	1:100								part	
	Human Population Information	1:100									

Theme	Data	Scale	BIHO	CIRO	CRMO	HAFO	MIIN	NEPE	JODA	LARO	WHMI
	Tribal Reservations and Ceded Lands	1:100									
Disturbance	Fire Ignition Locations	1:100									
	Fire Boundaries / History	1:100									
	Fire Treatment Areas	1:24									
	Current (1990) Fire Regime	1:100									
	Historic (1900) Fire Regime	1:100									
	Grazing Allotments	1:100						part			
	Landfill	1:24									
Remotely Sensed / Base Layers	Quad Boundaries	1:24									
	Quad Boundaries	1:100									
	Digital OrthoPhoto Quads	Varies									
	Digital Raster Graphics	Varies									
	Aerial Photos	Varies									
	SPOT panchromatic	2.5m						part			
	SPOT panchromatic	10m						part			
	ASTER	15m									
	LandSat	30m									
	NAIP	1m						part			

Appendix E-3. Regional Monitoring

Air and Climate

AirData, US Environmental Protection Agency

The EPA has been monitoring various aspects of air pollution since the 1970s. The AirData web site (epa.gov/air/data) provides access to several of these databases including the Air Quality System, National Emission Inventory, Hazardous Air Pollutants and Criteria Air Pollutants. Within the UCBN, 173 sites monitor the 6 criteria pollutants (carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone, particulate matter and lead), in addition to other variables. Figure 7 shows the location of several EPA air quality monitoring networks in the UCBN region.

Department of Environmental Quality, Department of Ecology

Air quality programs are administered in all 4 states of the UCBN through the Department of Environmental Quality in Idaho, Oregon, and Montana and the Department of Ecology in Washington. The overall goals of these programs are to measure and evaluate levels of pollutants in the air and determine whether air quality is meeting federal and state air quality standards. Figure 7 shows the location of air quality stations in the UCBN.

SNOTEL, Natural Resources Conservation Service

Since 1980, the Natural Resources Conservation Service's SNOTEL data collection network has collected data necessary to produce water supply forecasts throughout the western US. The NRCS installs, operates, and maintains over 600 automated sites that collect a wide variety of snowpack and related climatic data including air temperature, precipitation, snow water content, snow depth, barometric pressure, relative humidity, wind speed and direction, solar radiation, soil moisture and soil temperature. No sites are located in UCBN parks but parks are situated within a network of regional sites and data generated from the network are applicable to UCBN parks.

Western Regional Climate Center, National Oceanic and Atmospheric Administration

The WRCC is one of 6 regional climate centers in the US and partners with the National Climatic Data Center and State Climate Offices to collect and provide current and historic climate data. Precipitation and temperature data in parts of the UCBN date back to at least 1880. Most UCBN parks have long-term climate data sets available through the WRCC collected from weather stations in nearby towns and airports.

Geology and Soils

Idaho National Engineering and Environmental Laboratory

In southeast Idaho, the INEEL supports a Seismic Monitoring Program including 27 seismic stations and 31 strong-motion accelerographs for the purpose of documenting earthquake activity on and around the eastern Snake River Plain. Initiated in 1971, the seismic network is used to acquire information on earthquake sources (such as locations, magnitudes, depths, fault dimensions, faulting style, and stress parameters), crustal structure, rock properties, and attenuation characteristics of the subsurface. The accelerograph network is used to determine the level of earthquake ground motions.

Pacific Northwest Seismograph Network

Funded by the USGS, the PNSN operates seismograph stations throughout Oregon and Washington. About 200 seismograph stations provide real-time data to locate earthquakes, estimate magnitude, and determine the strength of ground motion. Most sites are located in and around the Cascade Range, however, one station is located near Ft. Spokane at LARO and several are located north of the Clarno Unit of JODA near the Columbia Gorge.

Wildlife

Idaho National Engineering and Environmental Laboratory

The INEEL in southeast Idaho cover 890 sq. mi. of important habitat for many wildlife species. As part of their Environmental Surveillance, Education and Research Program, INEEL biologists conduct annual surveys for big game (elk, mule deer, antelope), sage grouse and predatory birds. In addition, breeding bird surveys are conducted in cooperation with the USGS.

North American Breeding Bird Survey

The BBS is a cooperative effort between the USGS's Patuxent Wildlife Research Center and the Canadian Wildlife Service's National Wildlife Research Centre. Following a standardized protocol, data are collected along over 3000 randomly established roadside routes to monitor the status and trends of North American bird populations. Routes are 24.5 mi long with observers stopping every 0.5 mi to record all birds seen and heard during a 3-minute point count. Over 100 routes are surveyed within the UCBN, approximately 20 of these occur on or near UCBN park units.

Christmas Bird Count, National Audubon Society

The CBC is an early-winter bird census conducted by the National Audubon Society. Volunteers count every bird seen or heard within a 15-mi diameter circle in 1 day. The primary objective of CBC is to monitor the status and distribution of bird populations across the Western Hemisphere. Most UCBN parks have CBC circles on or near parks, and CBC results have been incorporated into bird inventory results.

SAGEMAP, US Geological Survey

The SAGEMAP project, conducted by the Snake River Field Station of the USGS Forest and Rangeland Ecosystem Science Center, was initiated to identify and collect spatial data layers needed for research and management of sage grouse and shrub-steppe systems. More recently, SAGEMAP has become a repository for information related to the monitoring of greater sage-grouse.

Big Game Surveys, State agencies

Across the UCBN, state agencies (Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife and Montana Fish, Wildlife and Parks) conduct annual surveys to monitor the population status and trends of big game including elk, mule deer, whitetail deer, moose, bighorn sheep and mountain goat. Areas surveyed for each species vary annually, but often include areas on or near UCBN parks.

Partners in Flight

Begun in 1990, the goal of PIF is to focus resources on the improvement of monitoring and inventory, research, management, and education programs involving birds (primarily neotropical migrants) and their habitats. In conjunction with their cooperators, PIF has identified and developed a research and monitoring needs database. Recognized needs in the UCBN include monitoring population trends of landbirds in protected and restored pine forests and the population status and trends of colonial waterbirds.

USDA Forest Service Northern Region Landbird Monitoring Project

The goal of the NRLMP is to implement monitoring across the USFS Region 1 to provide a picture of landbird distributions, estimate overall population trends and allow an assessment of habitat relationships. Two UCBN parks (NEPE and BIHO) are within Region 1 and will benefit from information gathered with this project.

Northwest Bat Cooperative

This multi-agency cooperative includes the USFS Region 6, BLM, Plum Creek Timber Co., and the US Fish and Wildlife Service. Partners pool funds and identify and prioritize bat research and monitoring activities in the Pacific Northwest. Currently, the coop is supporting a long-term investigation of bat use of snags in mixed coniferous habitats of the eastern Cascades and central Idaho. Currently, the NPS is not a member of the coop but the UCBN may find that a partnership with this organization will benefit bat monitoring goals of the network.

Oregon/Washington Bat Grid Project

Led by USFS Region 6, this project is developing a region-wide bat monitoring program that may be employed within the UCBN in the future. Bat inventory data from JODA has already been shared with the project and, as the program expands into Washington in 2005, data from LARO and WHMI will also be shared.

Western States Bat Working Group

The WBWG is comprised of agencies, organizations and individuals interested in bat research, management, and conservation from 13 western states and the provinces of British Columbia and Alberta. The goals of the group are: to facilitate communication among interested parties and reduce risks of species decline or extinction; to provide a mechanism by which current information regarding bat ecology, distribution, and research techniques can be readily accessed; and to develop a forum in which conservation strategies can be discussed, technical assistance provided, and education programs encouraged. Individual state chapters for Oregon, Washington, and Idaho are all developing state management plans that include monitoring and these will likely intersect with UCBN monitoring in the future.

StreamNet

StreamNet is a cooperative venture between tribal, state, and federal fish and wildlife agencies to provide a web-based repository of data for Pacific Northwest fish, habitat, and related attributes. StreamNet has data for all UCBN parks except BIHO, which is outside of the Columbia Basin.

State Fish and Wildlife Agencies

State Fish and Wildlife (Game) agencies conduct annual surveys for fish and game animals in or near many UCBN parks. Annual fish surveys are conducted along the John Day River, Columbia River, Snake River, Clearwater River, and Big Hole River and these data will be important to the UCBN monitoring program.

Vegetation

Idaho National Engineering and Environmental Laboratory
The INEEL in southeast Idaho cover 890 sq. mi. of fairly untouched habitat. Vegetation surveys are conducted to evaluate the impact of current and past management activities, evaluate long-term vegetation trends and monitor the invasion and impacts of cheatgrass.

VegBank, Ecological Society of America
VegBank is a fairly recent endeavor to link actual vegetation plot records with vegetation types recognized in the US National Vegetation Classification System and types recognized by ITIS/USDA. The vegetation plot database developed and maintained by VegBank will provide valuable contextual and long-term monitoring information throughout the UCBN.

Forest Inventory and Analysis, US Forest Service
The objectives of FIA are to determine the extent and condition of forest resources across the US and analyze how these resources change over time. Both periodic and/or annual inventories are collected in all states, are maintained in the FIA national database and include information on plot and subplot characteristics, vegetation condition, and live and mortality tree measurements. Permanently established plots are distributed across the landscape with approximately one plot every 6,000 acres.

Forest Health Monitoring, US Forest Service
In addition to the forest stand information collected at FIA plots, a subset (1 plot every 96,000 acres) is measured to monitor forest health. Measurements include a full vegetation inventory, tree and crown condition, soil characteristics, lichen diversity, coarse woody debris and ozone damage. Approximately 10% of the plots in the western US are measured every year.

Water

Idaho Department of Water Resources
IDWR maintains a database of ground water levels throughout Idaho. Data are collected on 1388 observation wells across the state through a cooperative program with the USGS. The purposes of these data are to study changes in water levels, evaluate ground water availability for new water uses and identify areas with declining ground water levels that may need administrative action. IDWR also maintains information on nitrate levels at 1615 sites.

Oregon Water Resources Department
The mission of the OWRD is to ensure a sufficient supply of water to sustain Oregon's growing economy, quality of life and natural heritage. The department monitors levels of ground and surface water to protect existing uses while maintaining adequate levels to support fish, wildlife and recreation.

Department of Environmental Quality, Department of Ecology

Water quality programs are administered in all 4 states of the UCBN through the Department of Environmental Quality in Idaho, Oregon, and Montana and the Department of Ecology in Washington. The overall goals of these programs are to measure and evaluate levels of pollutants in the water and determine whether water quality is meeting federal and state standards. While specific monitoring objectives and level of effort differ across the 4 states, aspects of river and stream flow, stream biology, and water quality are monitored. Several UCBN parks have DEQ monitoring sites located nearby. Water quality monitoring has been ongoing at Grand Coulee since 1949. Washington DEQ also regularly monitors water quality at Mill Creek adjacent to WHMI. Oregon DEQ sites are located above and below JODA on the John Day River.

Water Resources, US Geological Survey

In cooperation with state, county and other federal agencies, the USGS monitors surface and ground water levels as well as water quality across the US. Their National Water Information System Web Site maintains and distributes water data for approximately 1.5 million sites across the US from 1857 to present. Over 20,000 sites occur in Washington, Oregon, Idaho and Montana.

Literature Cited

Adams, M. J. 2000. Pond permanence and the effects of exotic vertebrates on anurans. Ecological Applications **10**:559-568.

Adams, M. J., C. A. Pearl and R. B. Bury. 2003. Indirect facilitation of an anuran invasion by non-native fishes. Ecology Letters **6**:343-351.

Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Island Press, Washington, D.C.

Allan, J. D. 1995. Stream Ecology: Structure and Function of Running Waters. London, Chapman and Hall.

Allan, J. D. 2004. Landscapes and riverscapes: the influence of land use on stream ecosystems. Annual Review of Ecology and Systematics **35**:257-84.

Anderson, C. R., B. L. Peckarsky and S. A. Wissinger. 1999. Tinajas of southeastern Utah: invertebrate reproductive strategies and the habitat templet. Invertebrates in Freshwater Wetlands of North America: Ecology and Management. D. P. Batzer, R. B. Rader, and S. A. Wissinger. New York, John Wiley and Sons**:** 791-810.

Anderson, M., P. Bourgeron, M. T. Bryer, R. Crawford, L. Engelking, D. Faber-Langendoen, M. Baker, B. W., H. C. Ducharme, D. C. S. Mitchell, T. R. Stanley and H. R. Peinetti. 2005. Interaction of beaver and elk herbivory reduces standing crop of willow. Ecological Applications **15**:110-118.

Baker, B. W., H. C. Ducharme, D. C. S. Mitchell, T. R. Stanley and H. R. Peinetti. 2005. Interaction of beaver and elk herbivory reduces standing crop of willow. Ecological Applications **15**:110-118.

Baker, W.L. and D. Ehle. 2001. Uncertainty in surface-fire history: the case of ponderosa pine forests in the western United States. Canadian Journal of Forest Research **31**: 1205-1226.

Baker, W.L. and D.J. Shinneman. 2004. Fire and restoration of pinyon-juniper woodlands in the western United States: a review. Forest Ecology and Management **189**: 1-21.

Baldwin, C. M., J. G. McLellan, M. C. Polacek and K. Underwood. 2003. Walleye predation on hatchery releases of kokanees and rainbow trout in Lake Roosevelt, Washington. North American Journal of Fisheries Management **23**:660-676.

Barber, M. E., S. T. J. Juul, R. E. Wierenga and W. H. Funk. 1999. Determining primary productivity of Lake Roosevelt with C-14. Journal of Environmental Engineering-Asce **125**:747-754.

Barrett, S. W., S. F. Arno, and J. P. Menakis. 1997. Fire episodes in the inland Northwest based on fire history data. USDA Forest Service, Intermountain Research Station. General Technical Report INT-GTR-370.

Beatley, T. 2000. Preserving biodiversity: challenges for planners. Journal of the American Planning Association **66**:5-21.

Beebee, R. A. and M. Manga. 2004. Variation in the relationship between snowmelt runoff in Oregon and ENSO and PDO. Journal of the American Water Resources Association **40**:1011-1024.

Belsky, A. J. 1996. Viewpoint: Western juniper expansion: Is it a threat to arid northwest ecosystems? Journal of Range Management **49**:53-59.

Bertollo, P. 1998. Assessing ecosystem health in governed landscapes: A framework for developing core indicators. Ecosystem Health **4**:33-51.

Beschta, R. L. 2005. Reduced cottonwood recruitment following extirpation of wolves in Yellowstone's northern range. Ecology **86**:391-403.

Bilton, D. T., J. R. Freeland and B. Okamura. 2001. Dispersal in freshwater invertebrates. Annual Review of Ecology and Systematics **32**:159-181.

Black, A. R., G. W. Barlow and A. T. Scholz. 2003. Carbon and nitrogen stable isotope assessment of the Lake Roosevelt aquatic food web. Northwest Science **77**:1-11.

Blus, L. J., C. S. Staley, C. J. Henny, G. W. Pendleton, T. H. Craig, E. H. Craig, and D. K. Halford. 1989. Effects of organophosphorus insecticides on sage grouse in southeastern Idaho. Journal of Wildlife Management **53**:1139–1146.

Bonar, S. A., L. G. Brown, P. E. Mongillo and K. Williams. 2000. Biology, distribution and management of burbot (Lota lota) in Washington state. Northwest Science **74**:87-96.

Brigham, R. M., H. D. Aldridge, and R. L. Mackey. 1992. Variation in habitat use and prey selection by Yuma bats, *Myotis yumanensis*. Journal of Mammalogy **73**:640-645.

Brown, D. J., W.A. Hubert, and S.J. Anderson. 1996. Beaver ponds create wetland habitat for birds in mountains of southeastern Wyoming. Wetlands **16**:127-133.

Buechner, M., C. Schonewald-Cox, R. Sauvajot, and B. A. Wilcox. 1992. Cross-boundary issues for national parks: What works “on the ground.” Environmental Management **16**:799-809.

Bunting, S. C., J. L. Kingery, M. A. Hemstrom, M. A. Schroeder, R. A. Gravenmier, and W. J. Hann. 2002. Altered rangeland ecosystems in the Interior Columbia Basin. USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon. General Technical Report PNW-GTR-553.

Bureau of Land Management. 2002. Management considerations for sagebrush (*Artemisia*) in the western United States: A selective summary of current information about the ecology and biology of woody North American sagebrush taxa. USDI Bureau of Land Management, Washington, D.C.

Caudill, C. C. 2003. Measuring dispersal in a metapopulation using stable isotope enrichment: high rates of sex-biased dispersal between patches in a mayfly metapopulation. Oikos **101**:624-630.

Cissel, J. H., F. J. Swanson, and P. J. Weisberg. 1999. Landscape management using historical fire regimes: Blue River, Oregon. Ecological Applications **9**:1217-1231.

Connelly, J. W., H. W. Browers, and R. J. Gates. 1988. Seasonal movements of sage grouse in southeastern Idaho. Journal of Wildlife Management **52**:116–122.

Connelly, J. W., M. A. Sanders, A. R. Sands, and C. E. Brown. 2000. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin **28**:967-985.

Corkran, C. and C. Thoms. 1996. Amphibians of Oregon, Washington, and British Columbia. Lone Pine Publishing, Renton, Washington.

Cowardin, L. M., V. Carter, F. C. Golet, and E. D. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Publication FWS/OBS-79/31. U.S. Department of Interior Fish and Wildlife Service, Office of Biological Services, Washington D.C.

Cummins, K.W. and R.W. Merritt. 2001. Application of invertebrate functional groups to wetland ecosystem function and biomonitoring. Pages 85-112 *in* Rader, R.B., D.P. Batzer, and S.A. Wissinger, editors. Bioassessment and management of North American freshwater wetlands. John Wiley and Sons, New York.

Curry-Lindahl, K. 1972. Ecological research and management. Pages 197-213 *in* Osten, R., editor. World national parks: Progress and opportunities. IUCN, Brussels.

D'Antonio, C. M. 2000. Fire, plant invasions, and global changes. Pages 65-93 *in* Mooney, H. A. and R. J. Hobbs, editors. Invasive species in a changing world. Island Press, Washington, D.C.

D'Antonio, C. M. and P. M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecological Systems **23**:63-87.

Dixon, Rita. 2004. Avian Inventory of Nez Perce National Historical Park and Big Hole National Battlefield. USGS Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho.

Dobkin, D. S. 1995. Management and conservation of sage grouse, denominative species for the ecological health of shrubsteppe ecosystems. USDI Bureau of Land Management, Portland, Oregon.

Dobkin, D. S., A.C. Rich, and W. H. Pyle. 1998. Habitat and avifaunal recovery from livestock grazing in a riparian meadow system of the northwestern Great Basin. Conservation Biology **12**:209-221.

Dodson, S. I. 2005. Introduction to Limnology. Boston, McGraw Hill.

Dunning, J. B., B. J. Danielson, and H. R. Pulliam. 1992. Ecological processes that affect populations in complex landscapes. Oikos **65**:169-175.

Dwire, K. A. and J. B. Kauffman. 2003. Fire and riparian ecosystems in landscapes of the western USA. Forest Ecology and Management **178**:61-74.

Elliott, J. E., L. K. Wilson, C. J. Henny, S. F. Trudeau, F. A. Leighton, S. W. Kennedy and K. M. Cheng. 2001. Assessment of biological effects of chlorinated hydrocarbons in osprey chicks. Environ.Contam.Chem*.* **20**:866-879.

Elliott, J. E., M. M. Machmer, C. J. Henny, L. K. Wilson and R .J. Norstrom. 1998. Contaminants in osprey from the Pacific Northwest: I. Trends and patterns in polychlorinated dibenzo-p-dioxins and dibenzofurans in eggs and plasma. Archives of Environmental Contamination and Toxicology **35**:620-631.

Elliott, J. E., M. M. Machmer, L. K. Wilson and C. J. Henny. 2000. Contaminants in ospreys from the Pacific Northwest: II. Organochlorine pesticides, polychlorinated biphenyls and mercury, 1991-1997. Archives of Environmental Contamination and Toxicology **38**:93-106.

Era, B. and D. Serdar. 2001. Reassessment of toxicity of Lake Roosevelt sediments. Olympia, WA, Washington State Department of Ecology**.** Publication No. 01-03-043**.** 54 pages.

Everett, R.L., R. Schellhaas, D. Keenum, D. Spurbeck, and P. Ohlson. 2000. Fire history in the ponderosa pine/Douglas fir forests on the east slope of the Washington Cascades. Forest Ecology and Management **129**:207-225.

Ewins, P. J. 1997. Osprey (Pandion haliaetus) populations in forested areas of North America: changes, their causes and management recommendations. Journal of Raptor Research **31**:138-150.

Fahrig, L. 2001. How much habitat is enough? Biological Conservation **100**:65-74.

Fausch, K. D., C. E. Torgersen, C. V. Baxter and H. W. Li. 2002. Landscapes to riverscapes: Bridging the gap between research and conservation of stream fishes. Bioscience **52**:483-498.

Fenton, M. B. 2003. Science and the conservation of bats: where to next? Wildlife Society Bulletin **31**:6-15.

Flinders, J. T. 1999. Restoration of sage grouse in Strawberry Valley, Utah, 1998–99 report. Utah Reclamation Mitigation and Conservation Commission, Progress Report. BrighamYoung University, Provo, Utah, USA.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest ecosystem management: an ecological, economic, and social assessment. Portland, OR: U.S. Department of Agriculture; U.S. Department of the Interior [and others].

Foster, D. R. 2000. From bobolinks to bears: Interjecting geographical history into ecological studies, environmental interpretation, and conservation planning. Journal of Biogeography **27**:27-30.

Foster, D. R. 2002. Conservation issues and approaches for dynamic cultural landscapes. Journal of Biogeography **29**:1533-1535.

Franklin, J.F., T.A. Spies, R. Van Pelt, A.B. Carey, D.A. Thornburgh, D.R. Berg, D.B. Lindenmayer, M.E. Harmon, W.S. Keeton, D.C. Shaw, K. Bible, and J. Chen. 2002. Disturbance and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. Forest Ecology and Management **155**:399-423.

Gallyoun, K. Goodin, D. H. Grossman, S. Landaal, and others. 1998. International classification of ecological communities: Terrestrial vegetation of the United States. Volume II. The National Vegetation Classification System: List of types. The Nature Conservancy, Arlington, Virginia.

Garratt, K. 1984. The relationship between adjacent lands and protected areas: Issues of concern for the protected area manager. Pages 65-71 *in* McNeely, J. A., and K. R. Miller, editors. National parks, conservation and development: The role of protected areas in sustaining society. Proceedings of the World Congress on National Parks, Bali, Indonesia, October 11-22, 1982. Smithsonian Institute Press, Washington, D.C.

Gedney, D. R., D. L. Azuma, C. L. Bolsinger, and N. McKay. 1999. Western juniper in eastern Oregon. USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon. General Technical Report PNW-GTR-464.

Gottesfeld, A. S., M. A. Hassan, J. F. Tunnicliffe and R. W. Poirier. 2004. Sediment dispersion in salmon spawning streams: The influence of floods and salmon redd construction. Journal of the American Water Resources Association **40**:1071-1086.

Gregory, S. V., F. J. Swanson, W. A. McKee, and K. W. Cummins. 1991. Ecosystem perspective of riparian zones: Focus on links between land and water. Bioscience **41**:540-551.

Gregory, S., K. Boyer, A. Gurnell and (eds.). 2003. The Ecology and Management of Wood in World Rivers. American Fisheries Society Symposium 37. Bethesda, MD, American Fisheries Society.

Gresswell, R. E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Transactions of the American Fisheries Society **128**:193-221.

Griffis-Kyle, K.L. and P. Beier. 2003. Small isolated aspen stands enrich bird communities in southwestern ponderosa pine forests. Biological Conservation **110**:375-385.

Griffith, B. 1980. Coyotes and Mule Deer of John Day Fossil Beds National Monument: A Management Report. Oregon State University, Corvallis, Oregon 29 pp.

Grosbois, C. A., A. J. Horowitz, J. J. Smith and K. A. Elrick. 2001. The effect of mining and related activities on the sediment-trace element geochemistry of Lake Coeur d'Alene, Idaho, USA. Part III. Downstream effects: the Spokane River Basin. Hydrological Processes **15**:855-875.

Hall, R., J. L. Tank and M. F. Dybdahl. 2003. Exotic snails dominate nitrogen and carbon cycling in a highly productive stream. Frontiers in Ecology and the Environment **1**:407-411.

Hansen, A. J. and J. J. Rotella. 2002. Biophysical factors, land use, and species viability in and around nature reserves. Conservation Biology **16**:1112-1122.

Hansen, A. J., R. P. Neilson, V. H. Dale, C. H. Flather, L. R. Iverson, D. J. Currie, S. Shafer, R. Cook, P. J. Bartlein. 2001. Global change in forests: Responses of species, communities, and biomes. BioScience **51**:765-779.

Harding, J., EF Benfield, PV, Bolstad, GS Helfman, and EBD Jones III. 1998. Stream biodiversity: the ghost of land use past. Proc. Natl. Acad. Sci. USA **95**:14843-14847.

Hay, M. E., J. D. Parker, D. E. Burkepile, C. C. Caudill, A. E. Wilson, Z. P. Hallinan and A. D. Chequer. 2004. Mutualisms and aquatic community structure: The enemy of my enemy is my friend. Annual Review of Ecology Evolution and Systematics **35**:175-197.

Hays, D.W., M.J. Tirhi, and D.W. Stinson. 1998. Washington State status report for the sage grouse. Washington Department of Fish and Wildlife, Wildlife Management Program, Olympia, Washington. 62 pages.

Helfield, J. M. and R. J. Naiman. 2001. Effects of salmon-derived nitrogen on riparian forest growth and implications for stream productivity. Ecology **82**:2403-2409.

Henny, C. J., and J. L. Kaiser. 1996. Osprey population increase along the Willamette River, Oregon, and the role of utility structures, 1976-1993. Pages 97-108 *In* Raptors in human landscapes. Academic Press, London.

Henny, C. J., J. L. Kaiser, R. A. Grove, V. R. Bentley and J. E. Elliott. 2003. Biomagnification factors (fish to osprey eggs from the Willamette River, Oregon, USA) for PCDDs, PCDFs, PCBs and OC pesticides. Environmental Monitoring Assessment **84**: 275-315.

Henny, C. J., R. A. Grove, J. L. Kaiser and V. R. Bentley. 2004. An evaluation of osprey eggs to determine spatial residue patterns and effects of contaminants along the lower Columbia river, USA. Pages 369-388 *In* Chancellor, R. D. and B. U. Meyburg, eds., Raptors Worldwide, WWGBP/MME, Budapest, Hungary.

Hessburg, P.F. and J.K. Agee. 2003. An environmental narrative of inland northwest Unites States forests, 1800-2000. Forest Ecology and Management **178**:23-59.

Hessburg, P.F., B.G. Smith, R.B. Salter, R.D. Ottman, and E. Alvarado. 2000. Recent changes (1930s-1990s) in spatial patterns of interior northwest forests, USA. Forest Ecology and Management **136**:53-83.

Hickey, M. B., M. B. Fenton, K. C. MacDonald, and C. Soulliere. 2002. Metal contaminants in the fur of bats from Ontario and Quebec. Bulletin of Environmental Contamination and Toxicology **66**:699-706.

Hoffman, R. A. 1988. Craters of the Moon National Monument baseline inventory and monitoring (wildlife) final report-1988. Report B-88-4, University of Idaho, Cooperative Park Studies Unit, Moscow, Idaho.

Hovingh, P. 2004. Intermountain freshwater mollusks, USA: geography, conservation, and fish management implications. Monographs of the Western North American Naturalist **2**: 109-135.

Howett, C. 2000. Integrity as a value in cultural landscape preservation. Pages 186-207 *in* Alanen, A. R. and R. Z. Melnick, editors. Preserving cultural landscapes in America. Johns Hopkins University Press, Baltimore, Maryland.

Idaho State Climate Services. 2003. Idaho 1971-2000 normals. Department of Biological and Agricultural Engineering, University of Idaho, Moscow, Idaho. http://snow.ag.uidaho.edu/2000_normals/index.html (accessed 09/25/03).

Jackson, M. and B. Lockman. 2003. Update on limber pine decline and mortality on the Lewis and Clark National Forest, Montana. Forest Health Protection Report 03-4. USDA Forest Service, Northern Region, Missoula, MT.

Janes, S. 1977. Raptors of the John Day Fossil Beds National Monument. Oregon State University, Corvallis, Oregon 48 pp.

John, T. 1995. Vascular Flora of City of Rocks National Reserve: An Annotated Checklist.

Johnson, Jr., C. G. 1994. Forest health in the Blue Mountains: an ecologist's perspective on ecosystem processes and biological diversity. USDA Forest Service, Pacific Northwest Research Station. Portland, OR. General Technical Report PNW-GTR-339.

Jones, C., JH Lawton, and M Shachak. 1997. Positive and negative effects of organisms as physical ecosystem engineers. Ecology **78**:1946-1957.

Kalff, J. 2002. Limnology: Inland Water Ecosystems, Prentice Hall, Upper Saddle River, NJ.

Kauffman, J. B., A. S. Thorpe and E. N. J. Brookshire. 2004. Livestock exclusion and belowground ecosystem responses in riparian meadows of Eastern Oregon. Ecological Applications **14**:1671-1679.

Kauffman, J.B., R.L. Beschta, N. Otting, and D. Lytjen. 1997. An ecological perspective of riparian and stream restoration in the western United States. Fisheries **22**:12-24.

Keane, R. E., K. C. Ryan, T. T. Veblen, C. D. Allen, J. Logan, and B. Hawkes. 2002. Cascading effects of fire exclusion in the Rocky Mountain ecosystems: A literature review. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado. General Technical Report RMRS-GTR- 91.

Keller, B. 1997. Analysis of the thermal characteristics of maternity caves and bat species present at Craters of the Monument National Monument, Butte County, Idaho. Unpublished. Western Environmental Research Associates, Pocatello, Idaho.

Keller, B. and R.T. Saathoff. 1995. A survey of day roosting by Plecotus townsendii in lava tube caves at Crater of the Moon National Monument, Butte County, Idaho. Unpublished. Idaho State University Museum of Natural History, Pocatello, Idaho.

Keller, B.L. and R.T. Saathoff. 1996. A netting survey of water and cave areas by bats at Craters of the Moon National Monument, Butte County, Idaho. Unpublished. Idaho Museum of Natural History, Idaho State University, Pocatello.

Kershner, J. L., B. B. Roper, N. Bouwes, R. Henderson and E. Archer. 2004. An analysis of stream habitat conditions in reference and managed watersheds on some federal lands within the Columbia River basin. North American Journal of Fisheries Management **24**:1363-1375.

Knopf, F.L. and F.B. Samson. 1994. Scale perspectives on avian diversity in western riparian ecosystems. Conservation Biology **8**:669-676.

Knopf, F.L., R.R. Johnson, T. Rich, F.B. Samson, and C. Szaro. 1988. Conservation of riparian ecosystems in the United States. Wilson Bulletin **100**: 272-294.

Kolar, C. S. and D. M. Lodge. 2002. Ecological predictions and risk assessment for alien fishes in North America. Science **298**:1233-1236.

Koyama, A., K. Kavanagh and A. Robinson. 2005. Marine nitrogen in central Idaho riparian forests: evidence from stable isotopes. Canadian Journal of Fisheries and Aquatic Sciences. **62**:518-526.

La Pierre, Y. 1997. The taming of the view. National Parks **71**:30-35.

Laliberte, A. S. and W. J. Ripple. 2003. Wildlife encounters by Lewis and Clark: A spatial analysis of interactions between native Americans and wildlife. Bioscience **53**:994-1003.

Larrison, E.J. 1981. Mammals of Idaho. University of Idaho Press, Moscow, Idaho.

Larson, E. J. and W. J. Ripple. 2003. Aspen age structure in the northern Yellowstone ecosystem: USA. Forest Ecology and Management **179**: 469-482.

Lawler, J.J. and T.C. Edwards. 2002. Composition of cavity-nesting bird communities in montane aspen woodland fragments: the role of landscape context and forest structure. Condor **140**:890-896.

Lee, J. R., and C. R. Peterson. 2003. Herpetological inventory of Craters of the Moon National Monument 1999-2001. Final report to Craters of the Moon National Monument and Preserve, National Park Service.

Levin, P. S., S. Achord, B. E. Feist and R. W. Zabel. 2002. Non-indigenous brook trout and the demise of Pacific salmon: a forgotten threat? Proceedings of the Royal Society of London Series B-Biological Sciences **269**:1663-1670.

Lewis, S. E. 1995. Roost fidelity of bats: a review. Journal of Mammalogy **76**:481-496.

Logan, J.A. and J.A. Powell. 2001. Ghost forests, global warming, and the mountain pine beetle. American Entomologist **47**:160-172.

Long, J. 2003. Diversity, complexity, and interactions: an overview of Rocky Mountain forest ecosystems. Tree Physiology **23**:1091-1099.

Lytle, D. A. and N. L. Poff. 2004. Adaptation to natural flow regimes. Trends in Ecology & Evolution **19**:94-100.

Mack, R. N. 1981. Invasion of *Bromus tectorum* L. into western North America: An ecological chronicle. Agroecosystems **7**:145-165.

Mack, R. N. and C. M. D'Antonio. 1998. Impacts of biological invasions on disturbance regimes. Trends in Ecology and Evolution **13**:195-198.

Mackey, R. L. and R. M. R. Barclay. 1989. The influence of physical clutter and noise on the activity of bats over water. Canadian Journal of Zoology **67**:1167-1170.

Madison, E., K. Oelrich, T. Rodhouse, and L. Garrett. 2003. Mammal Inventories, City of Rocks National Reserve. University of Odaho, Moscow, Idaho. 43 pp.

Madison, E., T. Rodhouse, and L. Garrett. 2003. Mammal Inventory – Craters of the Moon National Monument and Preserve. University of Idaho, Moscow, Idaho. 61 pp.

Majewski, M. S., S. C. Kahle, J. C. Ebbert and E. G. Josberger. 2003. Concentrations and Distribution of Slag-Related Trace Elements and Mercury in Fine-Grained Beach and Bed Sediments of Lake Roosevelt, Washington, April–May 2001, U.S. Geological Survey**.** Water-Resources Investigations Report 03-4170. 38 pages.

Marcot, B. 1996. An ecosystem context for bat management: a case study of the interior Columbia River Basin, USA. Pages 19-38 *in* Barclay, R.M.R. and R.M. Brigham, editors. Bats and Forests Symposium, October 19-21, 1995. Victoria, British Columbia, Canada. B.C. Ministry of Forestry, Victoria, B.C.

Martin, R.E. and D.B. Sapsis. 1991. Fires as agents of biodiversity: pyrodiversity promotes biodiversity. Pages 150-157 *in* J. LeBlance, editor. Biodiversity of Northwestern California. Proc. Symp. Santa Rosa, CA.

McCaffrey, M. T. Rodhouse, and L. Garrett. 2003. 2003 Vertebrate Inventory Lake Roosevelt National Recreation Area. University of Idaho, Moscow, Idaho. 61 pp.

McKinstry, M. C., W. A. Hubert, S. H. Anderson, eds. 2004. Wetland and Riparian of the Intermountain West: Ecology and Management. University of Texas Press, Austin, Texas.

McLellan, H. J., J. G. McLellan and A. T. Scholz. 2004. Evaluation of release strategies for hatchery kokanee in Lake Roosevelt, Washington. Northwest Science **78**:158-167.

Medin, D. E. (1990). Bird Populations in and Adjacent to a Beaver Pond Ecosystem in Idaho. USDA Forest Service Intermountain Research Station Research Paper(432):U1-U6.

Meffe, G. K. and C. R. Carroll. 1997. Conservation reserves in heterogeneous landscapes. Pages 305-346 *In* Meffe, G. K. and C. R. Carroll, eds. Principles of conservation biology. 2nd Edition. Sinauer Associates, Sunderland, Massachusetts.

Melnick, R. Z. 2000. Considering nature and culture in historic landscape preservation. Pages 22-43 *in* Preserving cultural landscapes in America. Alanen, A. R. and R. Z. Melnick, editors. Johns Hopkins University Press, Baltimore, Maryland.

Meyer, G.A., and J.L. Pierce. 2003. Climate controls on fire induced sediment pulses in Yellowstone National Park and central Idaho: a long-term perspective. Forest Ecology and Management **178**:89-104.

Miller, R. F. and J. A. Rose. 1999. Fire history and western juniper encroachment in sagebrush steppe. Journal of Range Management **52**:550-559.

Monello, R.J. and R.G. Wright. 1998. I. Exotic Pest Plant Inventory, Mapping and Priorities for Control in Parks in the Pacific Northwest, and II. Initial Bird and Small Mammal Survey Results for Parks in the Pacific Northwest. USGS Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho. 30 pp.

Munn, M. D. 2000. Contaminant trends in sport fish from Lake Roosevelt and upper Columbia River, Washington, 1994 - 1998: U.S. Geological Survey Water-Resources Investigations Report 00-4024. 13 pages.

Myers, N. 1972. National parks in savannah Africa. Science 178:1255-1263.

Naiman, R. and H. Decamps. 1997. The ecology of interfaces: riparian zones. Annual Review of Ecology and Systematics **28**: 621-658.

Naiman, R. J., C.A. Johnston, and J.C. Kelley. 1988. Alteration of North American streams by beaver. Bioscience **38**:753-762.

Naiman, R. J., G. Pinay, C.A. Johnston, and J. Pastor. 1994. Beaver influences on the long-term biogeochemical characteristics of boreal forest drainage networks. Ecology **75**:905-921.

Naiman, R. J., R. E. Bilby, eds. 1998. River Ecology and Management: Lessons from the Pacific Coastal Region. New York, Springer.

Naiman, R. J., R. E. Bilby, eds. 1998. River Ecology and Management: Lessons from the Pacific Coastal Region. New York, Springer.

Naiman, R., and H Decamps. 1997. The ecology of interfaces: riparian zones. Annual Review of Ecology and Systematics **28**:621-658.

Naiman, R., JM Melillo, and JE Hobbie. 1986. Ecosystem alteration of boreal forest streams by beaver (*Castor canadensis*). Ecology **67**:1254-1269.

Naiman, R.J., R.E. Bilby, and P.A. Bisson. 2000. Riparian ecology and management in the Pacific coastal rain forest. Bioscience **50**: 996-1011.

National Park Service (NPS). 1980. State of the Parks -1980: A report to the congress. National Park Service, US Department of Interior, Washington, D.C.

National Park Service (NPS). 1993. Science and the National Parks II: Adapting to Change. Government Printing Office, Washington, DC.

National Park Service. 2003a. Outline for vital signs monitoring plans. Internal guidance document. USDI National Park Service, Inventory and Monitoring Program, Ft. Collins, Colorado.

National Parks and Conservation Association (NPCA). 1979. NPCA adjacent lands survey: No park is an island. National Parks and Conservation Magazine 53:4-9.

National Research Council. 1996. Upstream: salmon and society. Committee on protection and management of Pacific Northwest salmonids. National Academy Press, Washington D.C.

Naughton, G. P., C. C. Caudill, M. L. Keefer, T. C. Bjornn and L. C. Struehrenberg. 2005. Late season mortality during migration of radio-tagged adult sockeye salmon (*Onchorhynchus nerka*) in the Columbia River. Canadian Journal of Fisheries and Aquatic Sciences **62**:30-47.

Naveh, Z. 1982. Landscape ecology as an emerging branch of human ecosystem science. Pages 189-237 *in* MacFayden, A. and E. D. Ford, editors. Advances in Ecological Research. Academic Press, New York, New York.

Niwa, C. G., R. E. Sandquist, R. Crawford, T. J. Frest, T. Griswold, P. Hammond, E. Ingham, S. James, E. J. Johannes, J. Johnson, and others. 2001. Invertebrates of the Columbia River basin assessment area. USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon. General Technical Report PNW-GTR-512.

Noss, R., E. T. LaRoe, III, and J. M. Scott. 1995. Endangered ecosystems of the United States: A preliminary assessment of loss and degradation. National Biological Service, Washington, D.C. Biological Report 28.

O'Connell, M. 2000. Threats to waterbirds and wetlands: implications for conservation, inventory, and research. Wildfowl **51**: 1-15.

O'Shea, T. J. and T. A. Vaughan. 1999. Population changes in bats from central Arizona: 1972 and 1997. Southwestern Naturalist **44**:495-500.

Oelrich, K., T. Rodhouse, and L. Garrett. 2003. 2003 Vertebrate Inventory Hagerman Fossil Beds National Monument. University of Idaho, Moscow, Idaho. 61 pp.

Ohlsen, P. and R. Schellhaas. Unpublished report. Historical and current stand structure in Douglas-fir and ponderosa pine forests. USDA Forest Service, Wenatchee, Forestry Sciences Lab, Wenatchee, WA.

Oregon Climate Service. 2003. Zone 7 Climate data archives. Oregon State University College of Oceanic and Atmospheric Sciences. http://www.ocs.orst.edu/allzone/allzone7.html. (retrieved 1/10/03).

Paige, C. and S. A. Ritter. 1999. Birds in a sagebrush sea: Managing sagebrush habitats for bird communities. Partners in Flight Western Working Group, Boise, Idaho.

Parsons, S., K.J. Lewis, and J.M. Psyllakis. 2003. Relationships between roosting habitat of bats and decay of aspen in the sub-boreal forests of British Columbia. Forest Ecology and Management **177**:559-570.

Peckarsky, B. L., B. W. Taylor, and C. C. Caudill. 2000. Hydrologic and behavioral constraints on oviposition of stream insects: implications for adult dispersal. Oecologia **125**:186-200.

Peet, R. K. 2000. Forests and meadows of the Rocky Mountains. Pages 75-121 *in* Barbour, M. G. and W. D. Billings, editors. North American terrestrial vegetation, second edition. Cambridge University Press, Cambridge, United Kingdom.

Pierce, John R. 1982. A Floristic Study of the Big Hole National Battlefield. University of Montana. Missoula, Montana. 265pp.

Pierson, E. D. 1998. Tall trees, deep holes, and scarred landscapes: conservation biology of North American bats. Pages 309-325 *in* T.H. Kunz and P.A. Racey, editors. Bat biology and conservation. Smithsonian Institution Press, Washington D.C.

Poff, N. L., J. D. Allan, M. A. Palmer, D. D. Hart, B. D. Richter, A. H. Arthington, K. H. Rogers, J. L. Meyers and J. A. Stanford. 2003. River flows and water wars: emerging science for environmental decision making. Frontiers in Ecology and the Environment **1**:298-306.

Poff, N. L., J. D. Allan, M. B. Bain, J. R. Karr, K. L. Prestegaard, B. D. Richter, R. E. Sparks and J. C. Stromberg. 1997. The natural flow regime: A paradigm for river conservation and restoration. Bioscience **47**: 769-784.

Pollock, M. M., M. Heim and D. Werner. 2003. Hydrologic and geomorphic effects of beaver dams and their influence on fishes. American Fisheries Society Symposium **37**:213-233.

Pollock, M., RJ Naiman, HE Erikson, CA Johnston, J Pastor, and G Pinay. 1995. Beavers as engineers: influences on biotic and abiotic characteristics of drainage basins. *in* Linking species and ecosystems. C. Jones, and J.H. Lawton (eds). New York, Chapman and Hall**:** 117-126.

Postel, S., and B. Richter. 2003. Rivers for Life: Managing Water for People and Nature. Washington, Island Press.

Prather, T. 2003. City of Rocks Invasive Plant Inventory. University of Idaho, Moscow, Idaho. 7 pp.

Prather, T. 2003. Lake Roosevelt Invasive Plant Inventory. University of Idaho, Moscow, Idaho. 7 pp.

Quigley, T. M. and S. J. Arbelbide, editors. 1997. An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins, Volumes I-III. USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon. General Technical Report PNW-GTR-405.

Quinn, T. P. 2005. The Behavior and Ecology of Pacific Salmon. Bethesda, MD, American Fisheries Society.

Quinn, T. P., R. S. Nemeth and D. O. McIsaac. 1991. Homing and Straying Patterns of Fall Chinook Salmon in the Lower Columbia River. Transactions of the American Fisheries Society **120**:150-156.

Rahel, F. J. 1997. From Johnny Appleseed to Dr. Frankenstein: Changing values and the legacy of fisheries management. Fisheries **22**:8-9.

Rahel, F. J. 2002. Homogenization of freshwater faunas. Annual Review of Ecology and Systematics **33**:291-315.

Reid, M., P. Comer, H. Barrett, S. Caicco, R. Crawford, C. Jean, G. Jones, J. Kagan, M. Karl, G. Kittel, and others. 2002. International classification of ecological communities: Terrestrial vegetation in the United States. Sagebrush vegetation of the western United States. Final Report for the USGS Forest and Rangeland Ecosystem Science Center, Boise, Idaho. NatureServe, Arlington, Virginia.

Richards, D. C., P. O'Connell and D. C. Shinn. 2004. Simple control method to limit the spread of the New Zealand mudsnail *Potamopyrgus antipodarum*. North American Journal of Fisheries Management **24**:114-117.

Rieman, B. E., C. H. Luce, R. E. Gresswell and M. K. Young. 2003. Introduction to the effects of wildland fire on aquatic ecosystems in the Western USA [Special Issue]. Forest Ecology and Management **178**:1-3.

Rodhouse, T. J. and R. G. Wright. 2004. 2003 study of bat roosts: John Day Fossil Beds National Monument. Report for cooperative agreement no. CA9088A00008. University of Idaho, Moscow, ID.

Rodhouse, T. J., M. F. McCaffrey, and R. G. Wright. 2005. Distribution, foraging behavior, and capture results of the spotted bat (*Euderma maculatum*) in central Oregon. Western.North American Naturalist **65**:215-222.

Rodhouse, T., A. St. John and L. Garrett. 2003. 2002-2003 Vertebrate Inventory Whitman Mission National Historic Site. University of Idaho, Moscow, Idaho 62 pp.

Rodhouse, T., A. St. John and L. Garrett. 2004. 2002-2003 Vertebrate Inventory John Day Fossil Beds National Monument. University of Idaho, Moscow, Idaho. 21 pp.

Rodhouse, T.J., M.F. McCaffrey, and R.G. Wright. 2005. Distribution, foraging behavior, and capture results of the spotted bat (*Euderma maculatum*) in central Oregon. Western.North American Naturalist **65**:215-222.

Rogers, P. 2002. Using forest health monitoring to assess aspen forest cover change in the southern Rockies ecoregion. Forest Ecology and Management **155**:223-236.

Rust, S.K. and C.L. Coulter. 2000. Composition, structure, and distribution of Utah juniper plant associations- Snake River Resource Area, Idaho.Conservation Data Center, Idaho Department of Fish and Game, Boise, ID.

Saunders, D. A., R. J. Hobbs, and C. R. Margules. 1991. Biological consequences of ecosystem fragmentation: a review. Conservation Biology **5**:18-32.

Schlosser, I. J. 1995. Dispersal, boundary processes, and trophic-level interactions in streams adjacent to beaver ponds. Ecology **76**:908-925.

Scholz, A. T., K. O'Laughlin, D. Geist, D. Peone, J. Uehara, L. Fields, T. Kleist, I. Zozaya, T. Peone and K. Teesatuskie. 1985. Compilation of information on salmon and steelhead total run size, catch and hydropower related losses in the Upper Columbia River Basin, above Grand Coulee Dam. Coeur d'Alene, ID and Cheney, WA. Upper Columbia United Tribes Fisheries Tech. Report No. 2. 165 pages.

Schonewald-Cox, C. M. 1988. Boundaries in the protection of nature reserves: Translating multidisciplinary knowledge into practical conservation. BioScience **38**:480-486.

Schuster, W.S.F., J.B. Mitton, D.K. Yamaguchi, and C.A. Woodhouse. 1995. A comparison of limber pine (Pinus flexilis) ages at lower and upper treeline sites east of the continental divide in Colorado. American Midland Naturalist **133**:101-111.

Shaffer, M. L. and B. A. Stein. 2000. Safeguarding our precious heritage. Pages 301-322 *in* Stein, B. A., L. S. Kutner, and J. S. Adams, eds. Precious Heritage: The status of biodiversity in the United States. Oxford University Press, New York, NY.

Shands, W. E. 1979. Federal resource lands and their neighbors. Conservation Foundation, Washington, D.C.

Sharp, B. 1985. Avifaunal changes in central Oregon since 1899. Western Birds **16**:63-70.

Shirley, S. 2004. The influence of habitat diversity and structure on bird use of riparian buffer strips in coastal forests of British Columbia, Canada. Canadian Journal of Forest Research **34**:1499-1510.

Shive, J. and C. Peterson. 2001. Herpetological Inventory of the City of Rocks National Reserve. Idaho State University, Pocatello, Idaho 64 pp.

Simberloff, D. 1999. The role of science in the preservation of biodiversity. Forest Ecology and Management **115**:101-111.

Sinclair, A. R. E. 1998. Natural regulation of ecosystems in protected areas as ecological baselines. Wildlife Society Bulletin **26**:399-409.

Sisk, T. D., A. E. Launer, K. R. Switky, and P. R. Ehrlich. 1994. Identifying extinction threats. BioScience **44**:592-604.

Smith, S. D., T. E. Huxman, S. F. Zitzer, T. N. Charlet, D. C. Housman, J. S. Coleman, L. K. Fenstermaker, J. R. Seemann, and R. S. Nowak. 2000. Elevated CO_2 increases productivity and invasive species success in an arid ecosystem. Nature **408**:79-82.

Sogge, M.K., and R.M. Marshall. 2000. A survey of current breeding habitats. Chap. 9 *in* Finch, D.M. editor. Status, ecology, and conservation of the willow flycatcher. U.S. Department of Agriculture, Forest Service, Albuquerque, NM.

Soulé, P. T., P. A. Knapp, and H. D. Grissino-Mayer. 2004. Human agency, environmental drivers, and western juniper establishment during the late Holocene. Ecological Applications **14**:96-112.

Stringham, T. K., W. C. Krueger, and P. L. Shaver. 2001. States, transitions, and thresholds: Further refinement for rangeland applications. Agricultural Experiment Station, Oregon State University, Corvallis, Oregon. Online. (http://www.ftw.nrcs.usda.gov/glti/pubs.html).

Strobel, C., L. Garrett and T. Rodhouse. 2003. Mammal and Herpetological Inventories Big Hole National Battlefield. University of Idaho, Moscow, Idaho. 34 pp.

Strobel, C., L. Garrett and T. Rodhouse. 2003. Mammal and Herpetological Inventories Nez Perce National Historical Park. University of Idaho, Moscow, Idaho. 34 pp.

Sweeney, B. W. et al. 2004. Riparian deforestation, stream narrowing, and loss of stream ecosystem services. Proceedings of the National Academy of Sciences of the United States of America **101**:14132-14137.

Tausch, R. J., P. E. Wigand, and J. W. Burkhardt. 1993. Viewpoint: plant community thresholds, multiple steady states, and multiple successional pathways: Legacy of the Quaternary? Journal of Range Management **46**:439-447.

Taylor, P. D. 2002. Fragmentation and cultural landscapes: Tightening the relationship between human beings and the environment. Landscape and Urban Planning **58**:93-99.

Taylor, P. D., L. Fahrig, K. Henein, and G. Merriam. 1993. Connectivity is a vital element of landscape structure. Oikos **73**:43-48.

Teidemann, A.R., J.O. Klemmedson, and E.L. Bull. 2000. Solution of forest health problems with prescribed fire: are forest productivity and wildlife at risk? Forest Ecology and Management **127**:1-18.

Thompson, W. L. and D. C. Lee. 2000. Modeling relationships between landscape-level attributes and snorkel counts of chinook salmon and steelhead parr in Idaho. Canadian Journal of Fisheries and Aquatic Sciences **57**:1834-1842.

Todd, M. and W. Elmore. 1997. Historical changes in western riparian ecosystems. Transactions of the 62nd North American Wildlife and Natural Resources Conference. Wildlife Management Institute, Washington D.C. Pages 1-17.

Torgersen, C. E., D. M. Price, H. W. Li and B. A. McIntosh. 1999. Multiscale thermal refugia and stream habitat associations of chinook salmon in northeastern Oregon. Ecological Applications **9**:301-319.

US Geological Survey. 2003. Ospreys in Oregon and the Pacific Northwest. USGS FS-153-02, US Department of Interior, Washington, DC.

US Geological Survey. 2002. Loss of sagebrush ecosystems and declining bird populations in the Intermountain West: Priority research issues and information needs. USDI Geological Survey, Boise, Idaho. FS-122-02.

USDA Forest Service. 1996. Status of the Interior Columbia Basin: Summary of scientific findings. USDA Forest Service, Pacific Northwest Research Station and USDI Bureau of Land Management. General Technical Report PNW-GTR-385.

Van Sickle, W. 1987. Survey of Vertebrates on the Big Hole National Battlefield. Wyoming Cooperative Fishery and Wildlife Research Unit. Laramie, Wyoming. 69pp.

Vannote, R. L., G.W. Minshall. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences **37**:130-137.

Veilleux, J. P. and S. L. Veilleux. 2004. Intra-annual and inter-annual fidelity to summer roost areas by female eastern pipistrelles, *Pipistrellus subflavus*. American Midland Naturalist **152**:196-200.

Verts, B.J. and L.N. Carraway. 1998. Land mammals of Oregon. University of California Press, Berkeley, California.

Vitousek, P. M., H. A. Mooney, J. Lubchenco, and J. M. Melillo. 1997. Human domination of Earth's ecosystems. Science 277:494-499.

Wagner, F. H., R. Angell, M. Hahn, T. Lawlor, R. Tausch, and D. Toweill. 2003. Natural ecosystems III. The Great Basin. Pages 207-240 *in* Wagner, F. H., editor. Rocky Mountain/Great Basin regional climate-change assessment. Report for the U.S. global change research program. Utah State University, Logan, Utah.

Wallin, D.O., F.J. Swanson, B. Marks, J.H. Cissel, and J. Kertis. Comparison of managed and pre-settlement landscape dynamics in forests of the Pacific Northwest, USA. Forest Ecology and Management **85**:291-309.

Wellborn, G. A., D. K. Skelly and E. E. Werner. 1996. Mechanisms creating community structure across a freshwater habitat gradient. Annual Review of Ecology and Systematics **27**:337-363.

West, N. E. and J. A. Young. 2000. Intermountain valleys and lower mountain slopes. Pages 255-284 *in* Barbour, M. G. and W. D. Billings, editors. North American terrestrial vegetation. Cambridge University Press, Cambridge, United Kingdom.

Western Regional Climate Center. 2003. Washington Climate Summaries. Desert Research Institute, Reno, Nevada. http://www.wrcc.dri.edu/summary/climsmwa.html (accessed 12/15/2003).

Western, D. 1982. Amboseli National Park: Enlisting landowners to conserve migratory wildlife. Ambio **11**:302-308.

Whitaker, J. O. 2004. Prey selection in a temperate zone insectivorous bat community Journal of Mamalogy **85**:460-469.

Whitaker, J. O., C. Maser, and S. P. Cross. 1981. Food habits of eastern Oregon bats, based on stomach and scat analysis. Northwest Science **55**:281-292.

Whitlock, C., S.L. Shafer, and J. Marlon. 2003. The role of climate and vegetation change in shaping past and future fire regimes in the northwestern US and the implications for ecosystem management. Forest Ecology and Management **178**:5-21.

Whittaker, R. H. 1967. Gradient analysis of vegetation. Biological Reviews of the Cambridge Philosophical Society **42**:207-264.

Wilcove, D. S., C. H. McLellan, and A. P. Dobson. 1986. Habitat fragmentation in the temperate zone. Pages 237-256 *in* Soulé, M., ed. Conservation biology: the science of scarcity and diversity. Sinauer Associates, Sunderland, Massachusetts.

Wilcove, D. S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 2000. Leading threats to biodiversity: What's imperiling US species? Pages 239-254 *in* Stein, B. A., L. S. Kutner, and J. S. Adams, eds. Precious Heritage: The status of biodiversity in the United States. Oxford University Press, New York, NY.

Wilkinson, C. E., M. D. Hocking and T. E. Reimchen. 2005. Uptake of salmon-derived nitrogen by mosses and liverworts in coastal British Columbia. Oikos **108**:85-98.

Wisdom, M. J., R. S. Holthausen, B. C. Wales, C. D. Hargis, V. A. Saab, D. C. Lee, W. J. Hann, T. D. Rich, M. M. Rowland, W. J. Murphy, and M. R. Eames. 2000. Source habitats for terrestrial vertebrates of focus in the Interior Columbia Basin: Broadscale trends and management implications. Volume 1-Overview. USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon. General Technical Report PNW-GTR-485.

Wissmar, R. C. 2004. Riparian corridors of Eastern Oregon and Washington: Functions and sustainability along lowland-arid to mountain gradients. Aquatic Sciences **66**:373-387.

With, K. A. and A. W. King. 1999. Extinction thresholds for species in fractal landscapes. Conservation Biology **13**:314-326.

Wright, G. M., J. S. Dixon, and B. H. Thompson. 1933. Fauna of the national parks: A preliminary survey of faunal relations in national parks. Fauna series No. 1. US Government Printing Office, Washington, D.C. Online (http://www.cr.nps.gov/history/online_books/fauna1/fauna.htm).

Wright, J. P., C. G. Jones and A. S. Flecker. 2002. An ecosystem engineer, the beaver, increases species richness at the landscape scale. Oecologia **132**:96-101.

Yahner, R. H. and D. P. Scott. 1988. Effects of forest fragmentation on depredation of artificial avian nests. Journal of Wildlife Management 52:158-161.

Yensen, D. L. 1981. The 1900 invasion of alien plants into southern Idaho. Great Basin Naturalist **41**:176-182.

Youtie, B. and A. H. Winward. 1977. Plants and Plant Communities of the John Day Fossil Beds National Monument. Oregon State University, Corvallis, Oregon 81 pp.

Zanetell, B. A. and B. L. Peckarsky. 1996. Stoneflies as ecological engineers - hungry predators reduce fine sediments in stream beds. Freshwater Biology **36**:569-577.